FEBRUARY 1977 75 CENTS

Popular Science

The What's New magazine®

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SECRETS OF SHARPENING

BIG BOATING SECTION:
- Ski-hull boat
- Windsurfing thrills
- Kevlar replace fiberglass?
- '77 outboards
- Hot cats
- Cuddy cabins
- Marine CB

ICE-BLOCK HOUSE cools with winter heat

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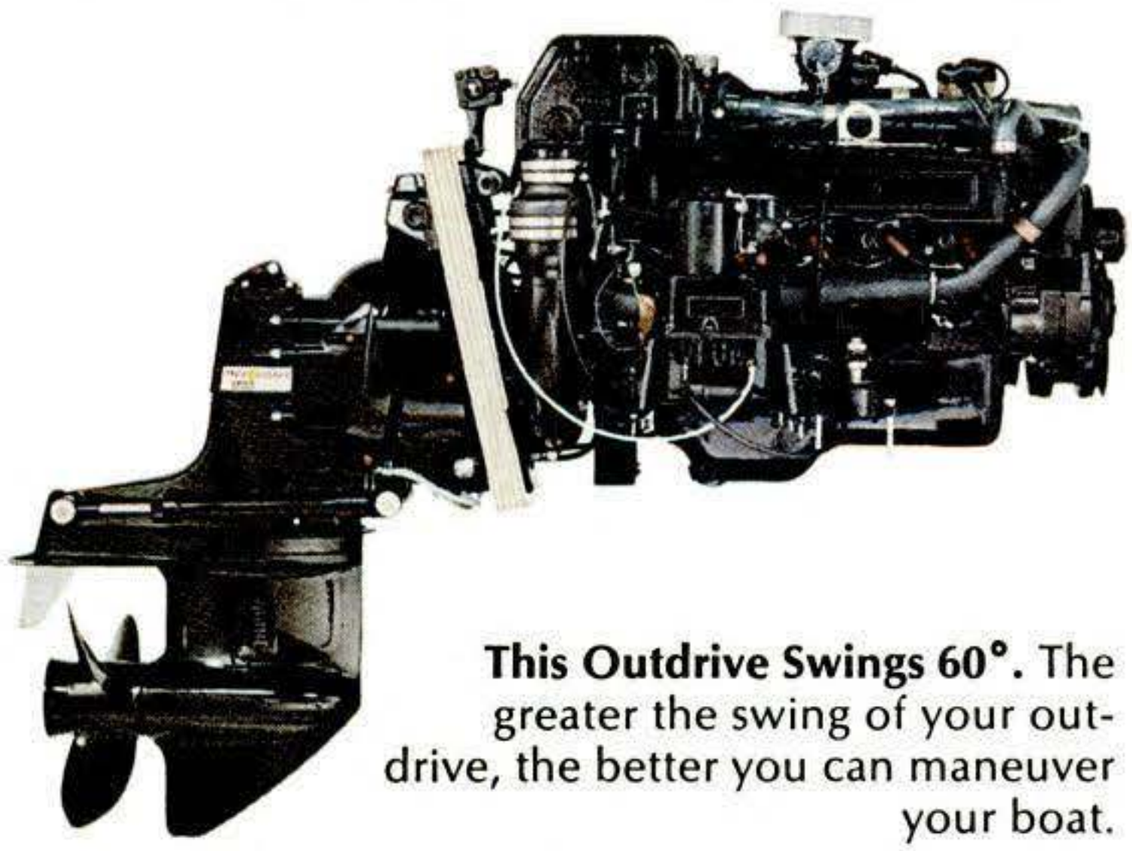

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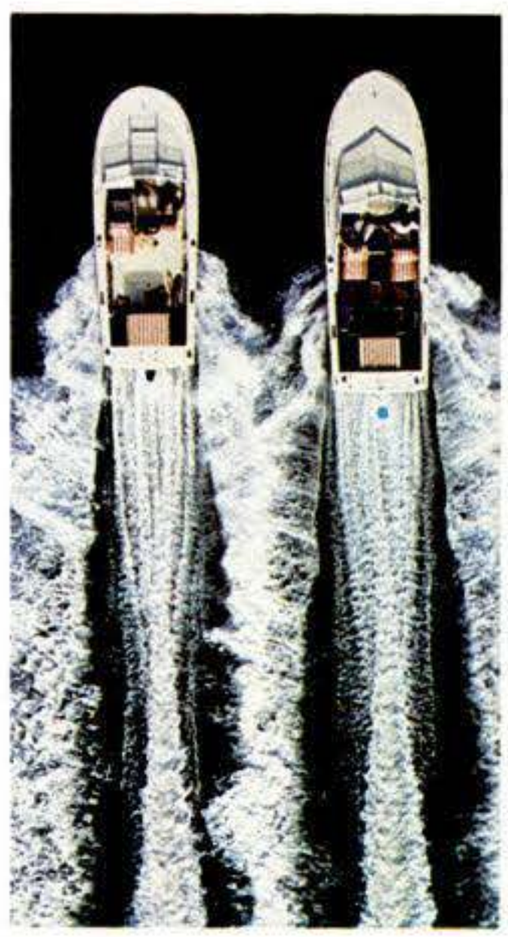

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FEBRUARY 1977
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Popular Science MONTHLY®

The What's New magazine

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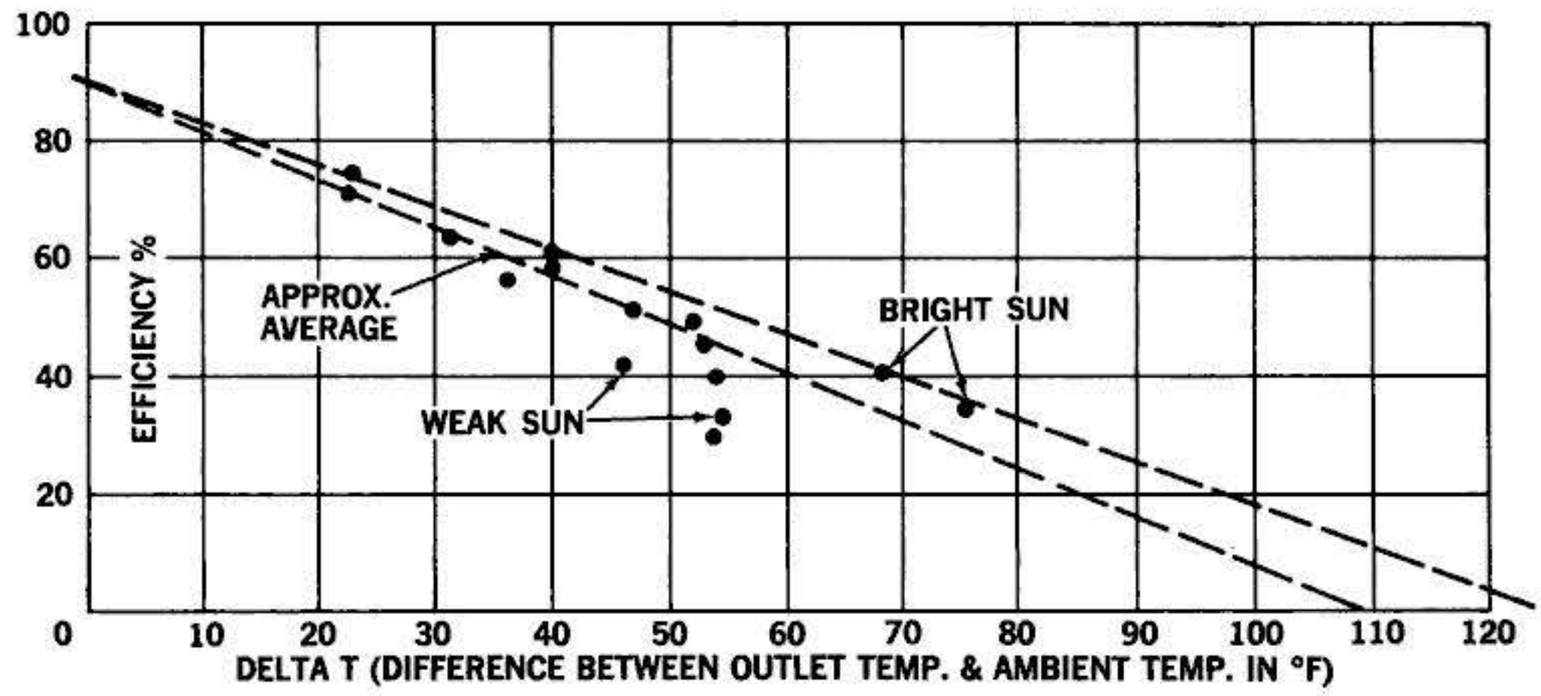

Editor's note: Before publication, PS sent copies of January's "Trickle Collectors: How Efficient?" to authorities mentioned in the text. Two of their replies follow.

90-percent efficiency

I appreciated your article. It was brief, to the point, and accurate in most areas.

One objection, however: The graph presented is based on *inlet* temperatures to the collector compared with ambient temperatures. Enclosed is a graph I have prepared from the University of Virginia's data based on *outlet* temperatures compared with ambient (above). I believe that data based on what you get *out* of a collector is the only accurate way to measure the true efficiency of solar collectors. As can be seen, Solaris' efficiency approaches 90 percent at low delta T.

I would also note that Solaris collectors were tested outdoors at the University of Virginia. This puts them at a substantial disadvantage compared to NASA's indoor testing of the other collectors shown on the graph in the article.

Harry E. Thomason, president,
Thomason Solar Homes, Inc.,
Washington, D. C.

A stream, not a trickle

Taylor Beard's test results on the Solaris collector agree very closely with similar but less exact tests I ran 10 years ago at the Yellott Solar Energy Laboratory in Phoenix.

Dr. Beard is quite correct when he says that "for high-temperature applications . . . a Solaris collector does not appear to compare well with the other flat-plate collectors." But no one would try to run an absorption air conditioner with a Solaris collector, and certainly not with an insolation as low as 350 watts per square meter or 111 Btu per hour per square foot.

Also, I feel it is misleading to refer to "dry" flat-plate collectors, because they are not dry (i.e., they use liquid as the heat-transfer medium); they simply use closed tubes rather than open channels. I prefer to use the terms closed-channel for the former type of collector and open-channel for the Solaris, because there is something at least mildly pejorative about the word "trickle."

Trickle's first definition is "to run or fall in drops" and this the collector certainly does not do. The second definition is more pleasant, "to flow in a thin gentle stream," and this is what Thomason accomplishes. I therefore vote for a more dignified term, which would be "open-channel collector" and stand united with Webster's New International Dictionary, edition of 1945.

Dr. John I. Yellott,
Arizona State University, Tempe, Ariz.

Addresses, please

I enjoy your magazine very much, but there is one thing that really frustrates

Continued

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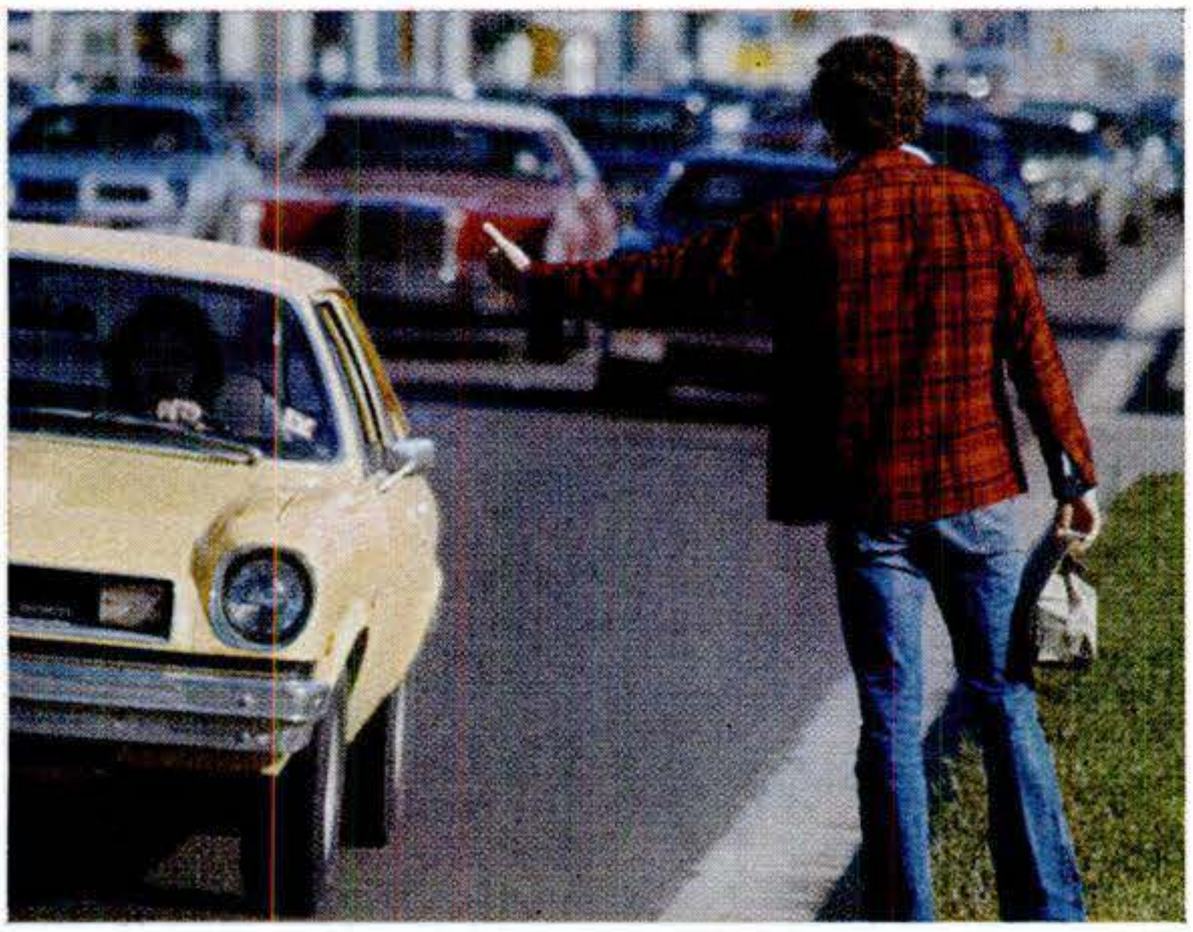

It always seems to happen at the most inopportune time. All of a sudden your car decides to up and just quit working — leaving you stranded.

What a helpless feeling. Nobody stops . . . nobody seems to care.

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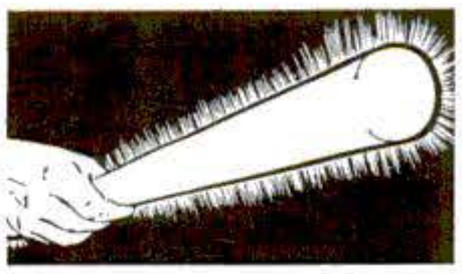

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PS readers talk back

[*Continued*]

me. You do not include a complete address for any of the industry or science sources that you quote or cite in your articles. It would certainly facilitate the flow of scientific information if you could list the addresses of the people mentioned in your fine magazine.

Richard T. Gregory, Department of Chemistry, University of Virginia, Charlottesville, Va.

Shellac solvent

Mr. Phillips' article on cleaning brushes [Oct. '76] was interesting and informative. However, someone who needed to clean shellac out of a brush would be left with a throwaway.

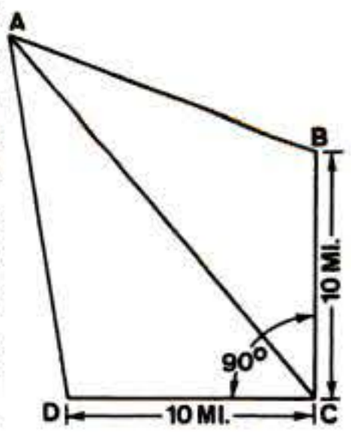
Shellac-filled brushes can be easily and thoroughly cleaned with alcohol, followed by a wash in ammonia water. I learned about this method from a *Popular Science* book authored by Mr. Jackson Hand.

Woodrow Brothers, Mt. Prospect, Ill.

Thirty-seven-year-old puzzle

For more than 37 years I have tried, on and off, to solve a problem that appeared in *Popular Science.*

All right, I give up. What's the answer? In the September, 1939 issue (page 14) the following letter appeared:



"Have enjoyed monkeying with the problems you print, for the last couple of years. Here's one that may make the boys scratch their heads a little: A man always drives at the same speed (his car probably has a governor on it). He makes it from A direct to C in 30 minutes; from A through B to C in 35 minutes; and from A through D to C in 40 minutes. How fast does he drive?

D.R.C., Sacramento, Calif."

It certainly looked easy, and I started to work on it. By 3 a.m. I had filled a lot of sheets of paper, both sides, with notations. In subsequent issues of *Popular Science,* all I could find on the subject was the following, in the November, 1939 issue:

"In regard to the problem submitted by D.R.C. of Sacramento, Calif. in the September issue. According to my calculations, the speed of the car must be 38.843 miles an hour. W.L.B., Chicago, Ill."

But the reader gave no hint of how he had arrived at that figure. It may or may not be correct. Over the years, I probably have shown the problem to more than 500 people. The usual reaction was to nod the head knowingly and start trying to find out what the hypotenuse of the right angle is. But

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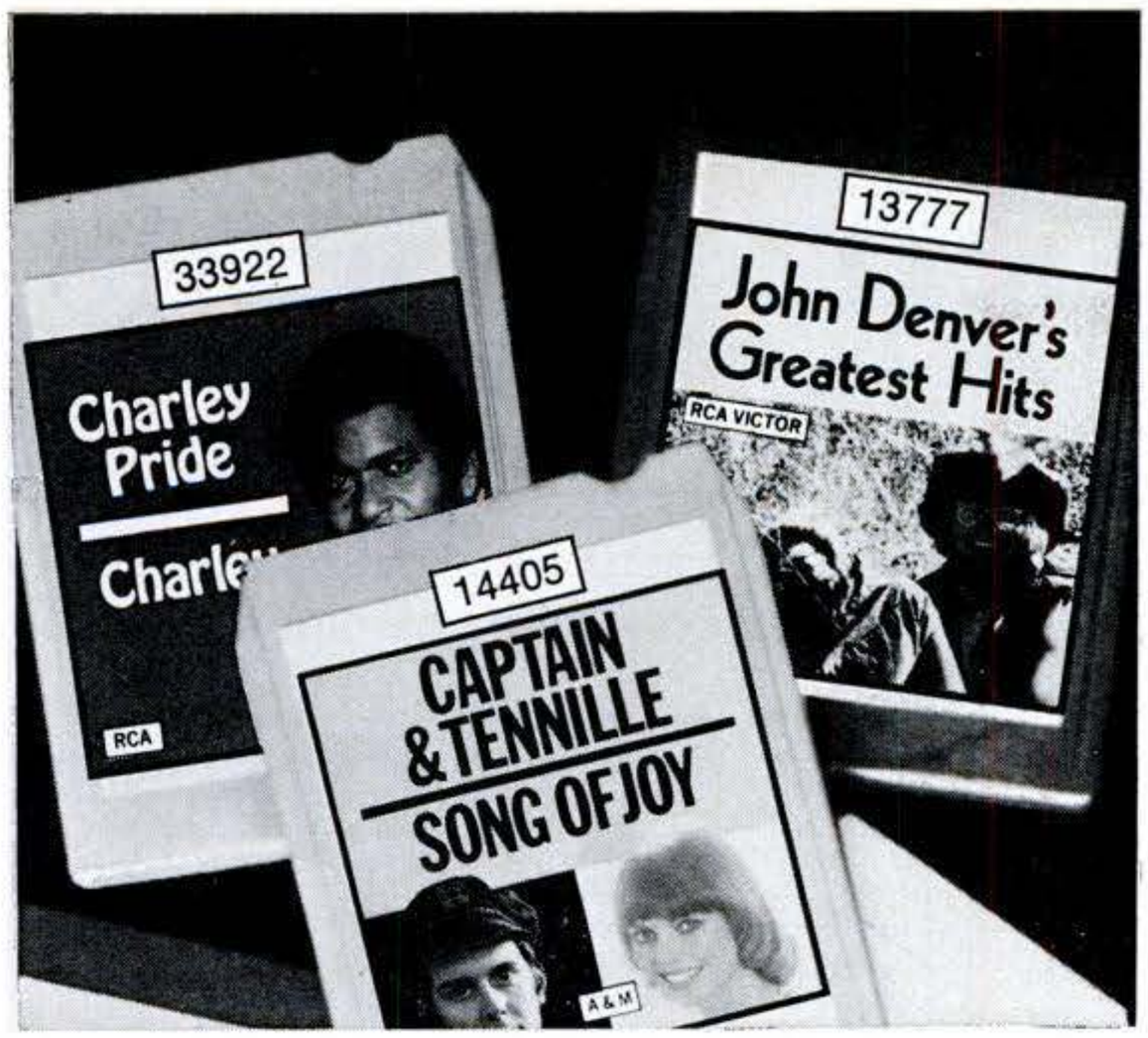

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The legend continues...

Mercedes-Benz presents a

Announcing an important new design from Mercedes-Benz. Sleek. Lean. With nimble handling. Ample space for five adults. Dozens of ingenious safety provisions. And fuel-injected power plants. The new Mercedes-Benz: Engineered like no other car in the world.

The new Mercedes-Benz required a full eight years to perfect. That may seem an almost leisurely pace.

However, when you come to understand the importance of this new Mercedes-Benz design, and the significance of its many engineering innovations, you'll see that it couldn't have been produced any faster.

New suspension

The design concept of the new Mercedes-Benz represents an exquisite balance among the needs for occupant protection, refined handling characteristics, and driver comfort. Maximizing each of these qualities required particular engineering finesse.

Perhaps the major achievement is the new front suspension. It is a simplified and strengthened front-end construction, buttressed with special gas-pressurized shock absorbers. It helps the new Mercedes-Benz deliver precise steering with instant response, virtually no lean in braking or cornering—and straight-line control on even the roughest roads. What's more, the lubricated-for-life ball joints are completely maintenance free.

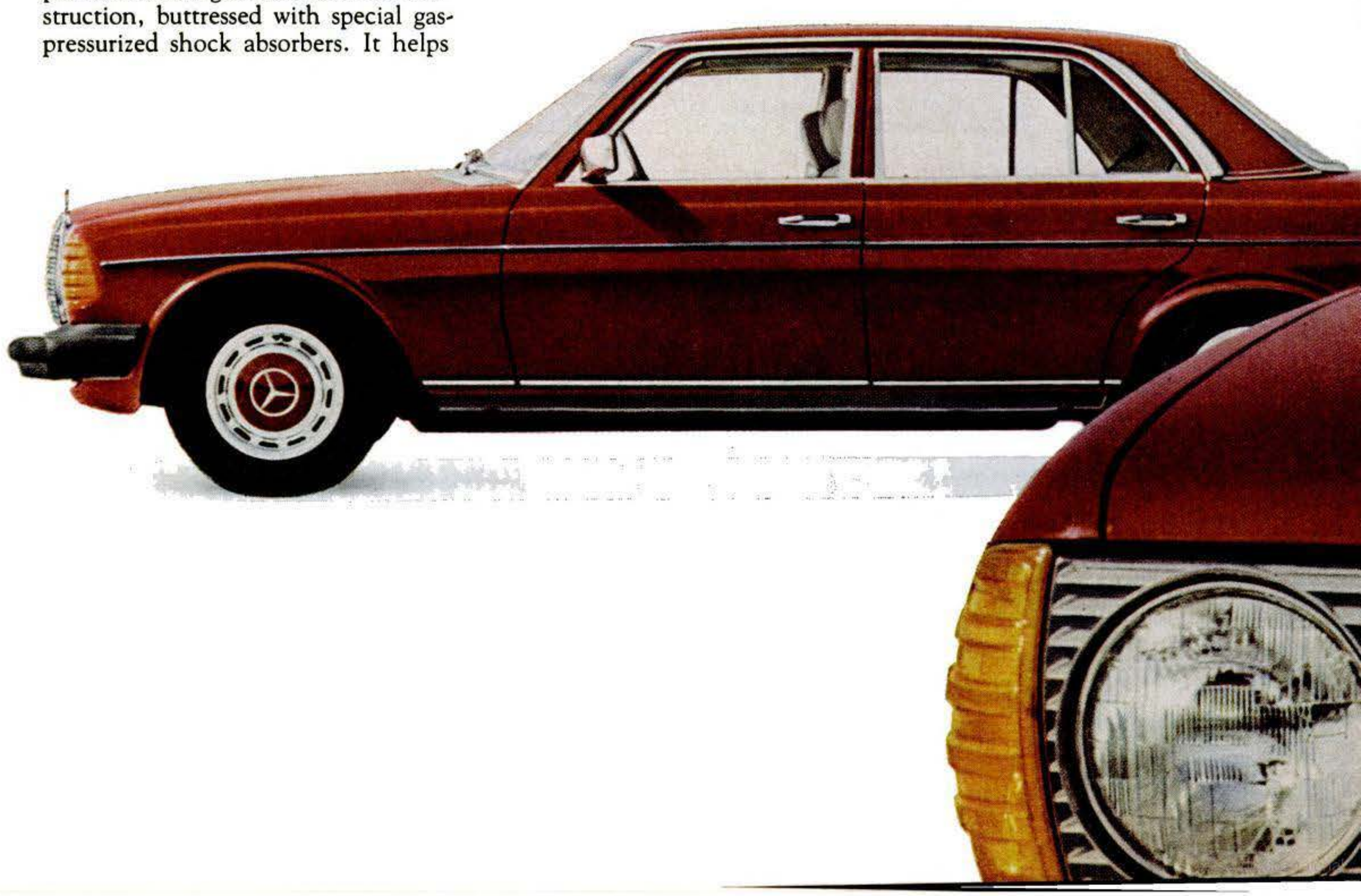
There are dual-circuit power disc brakes on all four wheels—just as there have been on all Mercedes-Benz automobiles since 1968.

The look of the future

This new design is a fresh look for Mercedes-Benz. Closer to the road.

Three distinctive models. Each one is fuel injected. One of them will meet your precise driving requirements.

240D	300D	280E
• Engine Type—Diesel, 4-cylinder, fuel injection, overhead camshaft, 5 main bearings	• Engine Type—Diesel, 5-cylinder, fuel injection, overhead camshaft, 6 main bearings	• Engine Type—6-cylinder, continuous fuel injection, double overhead camshafts, 7 main bearings
• Displacement—146.7 cu. in.	• Displacement—183.4 cu. in.	• Displacement—167.6 cu. in.
• Fuel/Fuel System—Diesel #2, mechanical fuel injection	• Fuel/Fuel System—Diesel #2, mechanical fuel injection	• Breakerless, transistorized ignition system
• Manual Transmission—4-speed, fully synchronized	• Automatic Transmission—4-speed, torque converter	• Automatic Transmission—4-speed, torque converter
• Curb Weight—3210 lbs.	• Curb Weight—3515 lbs.	• Curb Weight—3530 lbs.
• Overall Height—56.6"	• Overall Height—56.6"	• Overall Height—56.6"
• Overall Length—190.9"	• Overall Length—190.9"	• Overall Length—190.9"
• Turning Circle—37'	• Turning Circle—37'	• Turning Circle—37'
• Trunk Capacity—17.7 cu. ft.	• Trunk Capacity—17.7 cu. ft.	• Trunk Capacity—17.7 cu. ft.
• Passengers—5	• Passengers—5	• Passengers—5
• Wheelbase—110"	• Wheelbase—110"	• Wheelbase—110"



singular new achievement.

Slightly wider. Clean-limbed. The new effect is subtle but undeniable.

Inside, there's new luxuriousness, with ample front and rear legroom and headroom. And the trunk offers 17.7 cubic feet of usable space.

A perceptive observer may notice that all the frame members supporting the roof seem more slender than in previous Mercedes Benz models. Actually, these crucial safety members have been strongly reinforced. And their slim shape contributes to driver visibility. Another visibility aid: a total of 27.3 square feet of tinted glass.

The passenger compartment is a steel shell surrounded by lateral-impact-resistant elements, with crushable safety zones in front and rear.

The front safety zones are now creased for even more precisely defined deformation should an accident occur.

The rear crush path has been lengthened by moving the gas tank forward to a protected position above the rear axle.

And in front, the steering mechanism is positioned well behind the front wheels to protect it in a collision.

The aesthetics of safety

Study the dashboard's well-thought through details and take pleasure in them. The sense of stark elegance. The intelligent arrangement of switches and controls. The impressively sized steering wheel with a built-in safety chest pad. Anatomically designed seats. Impact-resistant handles on all doors.

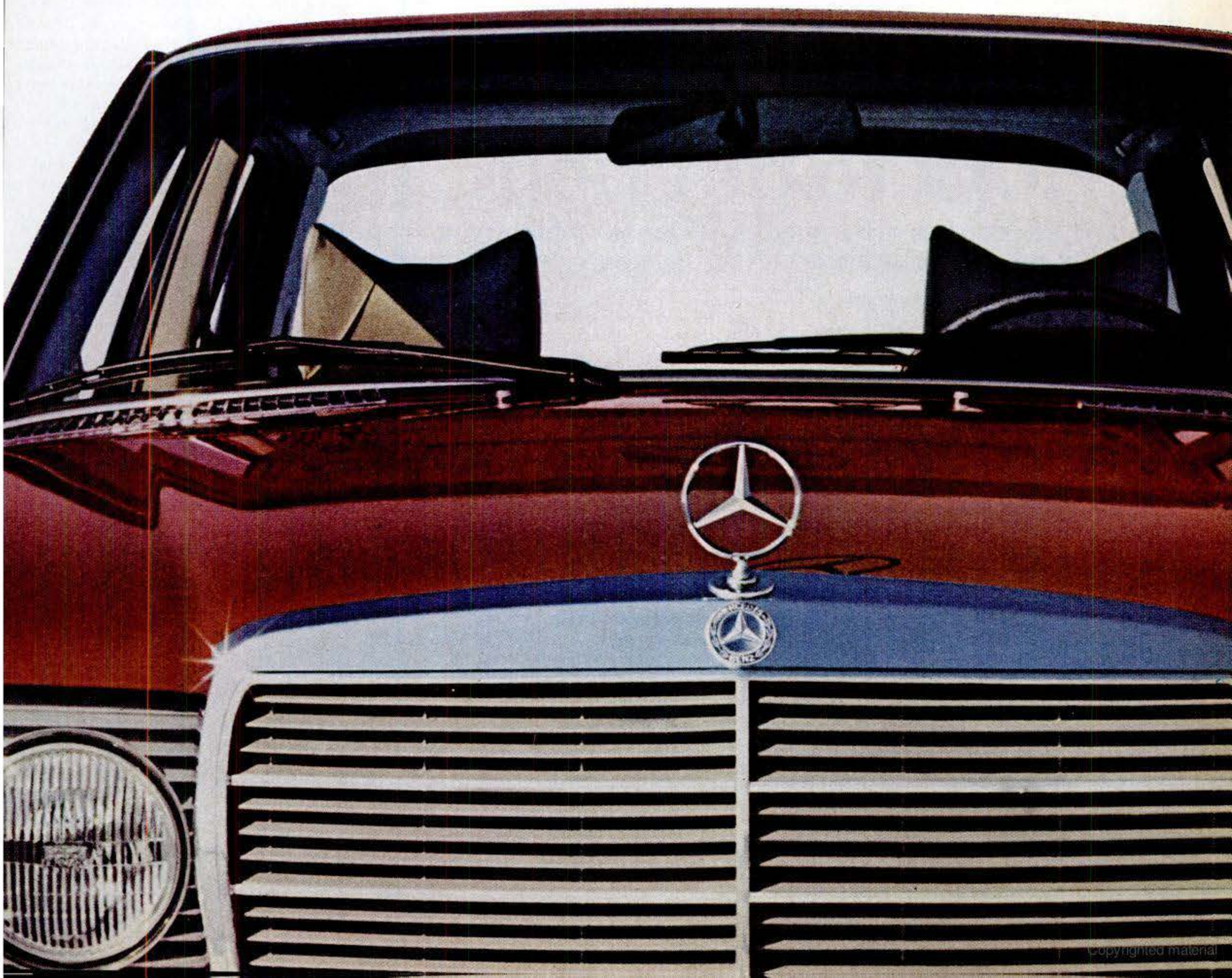
Fore and aft, a new type of energy-absorbing bumper flows smoothly into the car's silhouette.

The new Mercedes-Benz is, quite possibly, a masterpiece. A cursory look will indicate that. But only when you take the wheel will you recognize the significant difference between this and all other cars. Arrange a drive with your authorized Mercedes-Benz Dealer. Then you'll agree: the legend continues.

Mercedes-Benz

Engineered like no other car in the world.

©Mercedes-Benz, 1976



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How to get rich

START YOUR OWN BUSINESS RIGHT NOW FROM YOUR HOME—AND MAKE A FORTUNE IN MAIL ORDER!

Mail Order Beginners Get Cash by Mail!

Have you ever thought of operating a little mail order business of your own? Something you could start on a shoestring right from home in your spare time. It's a fabulous business!

Bob Carter of Newark, N.J. ran his first small mail order ad in House Beautiful magazine—offering an auto clothes rack. Business Week reported that his ad brought in $5,000 in orders. By the end of his first year in Mail Order, he had grossed over $100,000!

Another beginner—a lawyer from the midwest, sold a mail order item to fishermen. Specialty Salesman magazine reveals, "he made $70,000 the first three months!"

There is no other business where you can make a fortune so fast. Come up with a 'hot' new item . . . and WHAM!

It strikes like a bolt of lightning!

Millions of people read your ad and suddenly, you are swamped with cash orders from all over the country . . . MORE MONEY in 60 days than you could earn in a lifetime!

Like the Vermont dealer who ran one ad in Sports Afield magazine. His ad pulled 22,000 orders—over A HALF MILLION DOLLARS IN CASH!

Yes, Mail Order is the fastest-growing, most profitable business in America! And now with the population explosion . . . the huge teenage market . . . and more people moving to the suburbs—we are on the verge of the BIGGEST BOOM in Mail Order history!

Free

If you are sincerely interested in starting a lucrative business of your own ACT NOW! We can help you get rich in Mail Order just as we've helped others. Mail the coupon or send a postcard. We'll send you a free book, catalog, ads and complete facts about our offer. No salesman will call. No obligation. You don't need previous experience but you must be over 21. Write to:
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PS readers talk back

[*Continued*]

those few who remembered the formula then found there is little you can do with it when you know the hypotenuse distance.

Now I'd like to challenge *Popular Science*. If your readers of today cannot solve this little problem (and prove the answer) how about your finding the answer, if there is one, editors?

R. F. Davis, Sun City, Ariz.

Darrell Huff, master of the pocket calculator and frequent PS contributor [Feb. '76, June '75, Dec. '74] has come up with a couple of solutions. We'd like to see what you readers can do before we publish his answers.

Arc-welding advice

After reading E.F. Lindsley's November article, "Arc Welding," I felt I should write with some advice and warnings.

A great source of training and experience for the beginning welder can be found in many community adult-education programs and junior colleges. For a very modest fee, they offer quality instruction on techniques and safety.

Safety cannot be stressed enough. Adequate ventilation around all flux-coated rods is a must. The effects of failure to provide it are long-term. The proper "shade" of helmet lens must be used, and safety glasses (also shaded) should be worn under the hood—ultraviolet light can bounce behind the hood.

Buy quality equipment. Cheap equipment *feels* cheap, and is sometimes dangerous. Cheap equipment can make good work impossible and cause frustration.

Anyone who does welding on trailer hitches, auto frames, dune buggies, motorcycles, trailers, RV's, etc., should understand the legal and emotional consequences if those welds fail on the highway. A good, strong weld almost always *looks* good. Have pride and confidence in your work, and don't let anything off your property that may be questionable.

David Lee Vollbrecht, Eugene, Ore.

You need Aunt Sally

Enjoyed reading the article about pocket calculators by John Free ["Specialized Calculators," Nov. '76]. I have one question, however, about the example problem on page 60 (relative to the TI-30 calculator). Mr. Free states the problem as $3 + 10 - 2 \times 4^3 \div 32 = 9$. Somehow, I always come up with the answer as 22. Where have I gone wrong?

H. H. Fritz, Clearwater, Fla.

John Free replies: As the text indicates, you have to perform the operations in the right sequence: multiply, divide, add, subtract. The grammar-school mnemonic "My Dear Aunt Sally" says it all.

Want to get something off your chest?
Write "Readers Talk Back,"
Popular Science, 380 Madison Ave.,
New York, N.Y. 10017

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Great moments in the basement.

Making a shearing cut with a skew chisel may not be everybody's idea of kicks.

But for the man with a shop in the basement, and a lathe in the shop, it's one heck of a feeling.

Probably second only to seeing his own work take shape. An intricate chess piece. A cabriole leg. Or anything else that wood and skill and imagination can turn into something beautiful.

For the man like that, we make the Rockwell 14/11" Gap Bed Wood Lathe. One heck of a tool for $309.99*, for some very good reasons.

A ribbed, one-piece bed with inch-and-a-half, precision-ground ways.

A 14-inch swing over the gap, 11 inches over the bed, and 36 inches between centers.

A ball-bearing headstock, and an adjustable tailstock with a graduated ram.

A built-in indexing mechanism, and a precision-ground universal tool rest.

And four speeds, to handle any kind of wood (and plastic and metal).

All of which make it possible for you to make just about anything imaginable. Symmetrical, elliptical, helical. Beaded, chamfered, tapered. Whatever.

Of course, what goes into this lathe goes into every lathe we make, including our $169.99* 10-inch model. And into our radial-arm saws, table saws, band saws, jointers, drill presses, wood shapers and so on, on down to our 3/8-inch drills.

Real engineering. The kind that makes them unique. The kind that only comes with half a century of experience and on-the-job performance.

What that buys you is as good as you could ever want, short of actually having our big industrial equipment.

Namely, some impressive features, regardless of price. And the three things there are no substitute for in any tool, regardless of who makes it.

Accuracy. Power. Durability. With us, they're not just words. They're a reputation. The stuff that great moments are made of.

You can depend on it.

Rockwell. It's the same name industry's been depending on for 50 years.

Rockwell International

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For your local Rockwell dealer, phone toll free: 1-800-243-6100 (in Connecticut: 1-800-882-6500). Excluding Alaska and Hawaii.

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Photograph by
Valerie Taylor

THE GREAT WHITE SHARK!

One of the killers you'll encounter in DANGEROUS SEA CREATURES

Razor-edged tooth of a great white

The great white . . . most feared of the ocean's predators. He grows to a length of 30 feet, and to a weight of three tons. His teeth measure a full two inches, and are replaced, when damaged, within 24 hours. His acute sense of smell can detect one ounce of fish blood in one million ounces of water. His nerve endings can pick up erratic vibrations — such as those of a swimmer in trouble — at a distance of 600 feet. The great white claimed the lives of thousands of shipwreck victims during World War II . . . yet most attacks take place in waist-deep water! You've heard the myths about the great white shark . . . now, read the stranger-than-fiction truth about the deadliest of all sharks in *Dangerous Sea Creatures*. It's your first volume in the WILD, WILD WORLD OF ANIMALS library, based on the popular TIME-LIFE television series.

The great white is only one of the terrifying inhabitants of the deep. In *Dangerous Sea Creatures*, yours for 10-day free trial, you'll discover:

- **an electric ray,** capable of electrocuting its prey with a charge of up to 200 volts
- **the nurse shark,** which can clamp its jaws so tightly on its victim that the body can only be dislodged by killing the shark
- **a jellyfish** that grows to a length of eight feet, with stinging trailers extending up to 100 feet
- **the sea wasp,** whose venom is so potent, it can paralyze the heart of a man within 30 seconds after entering his bloodstream
- **the giant grouper,** capable of swallowing a diver *whole!*
- **the barracuda,** whose barely-detectable approach and razor-sharp teeth make him more feared than the shark in some parts of the world

Embark on an action-photo tour of the treacherous undersea world. More than 150 incredible full-color photographs (many of them taken by famed photographer Ron Taylor who has actually survived a white shark attack) give you a close-up view of the ocean's monsters second in drama only to actually confronting them. Send for *Dangerous Sea Creatures* for a 10-day free examination today — and begin a perilous journey to the ocean's floor.

The Zambezi shark of South Africa stalks its prey . . .

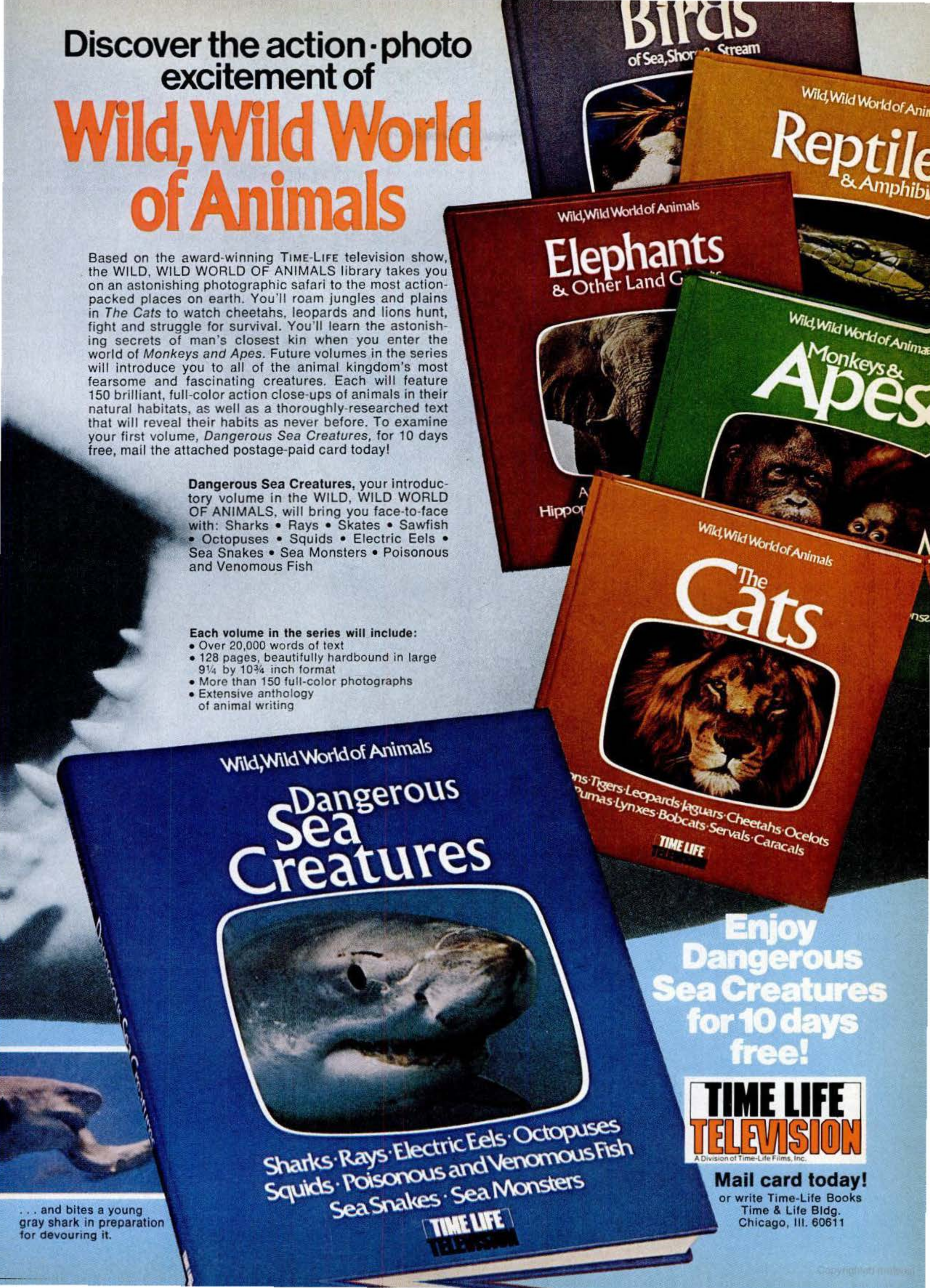
Discover the action·photo excitement of

Wild, Wild World of Animals

Based on the award-winning TIME-LIFE television show, the WILD, WILD WORLD OF ANIMALS library takes you on an astonishing photographic safari to the most action-packed places on earth. You'll roam jungles and plains in *The Cats* to watch cheetahs, leopards and lions hunt, fight and struggle for survival. You'll learn the astonishing secrets of man's closest kin when you enter the world of *Monkeys and Apes.* Future volumes in the series will introduce you to all of the animal kingdom's most fearsome and fascinating creatures. Each will feature 150 brilliant, full-color action close-ups of animals in their natural habitats, as well as a thoroughly-researched text that will reveal their habits as never before. To examine your first volume, *Dangerous Sea Creatures,* for 10 days free, mail the attached postage-paid card today!

Dangerous Sea Creatures, your introductory volume in the WILD, WILD WORLD OF ANIMALS, will bring you face-to-face with: Sharks • Rays • Skates • Sawfish • Octopuses • Squids • Electric Eels • Sea Snakes • Sea Monsters • Poisonous and Venomous Fish

Each volume in the series will include:
- Over 20,000 words of text
- 128 pages, beautifully hardbound in large 9¼ by 10¾ inch format
- More than 150 full-color photographs
- Extensive anthology of animal writing



. . . and bites a young gray shark in preparation for devouring it.

Enjoy Dangerous Sea Creatures for 10 days free!

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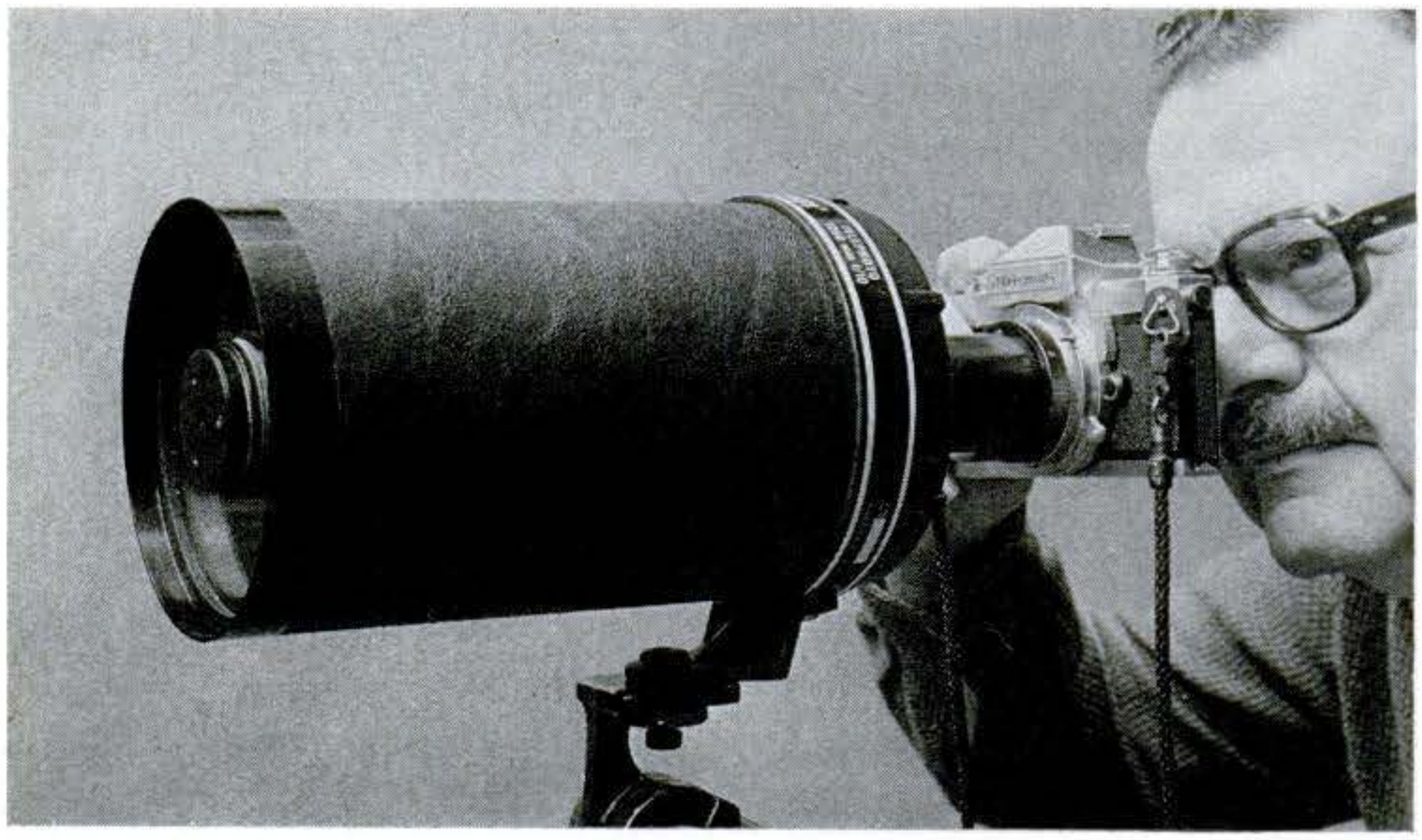
THROUGH THE VIEWFINDER

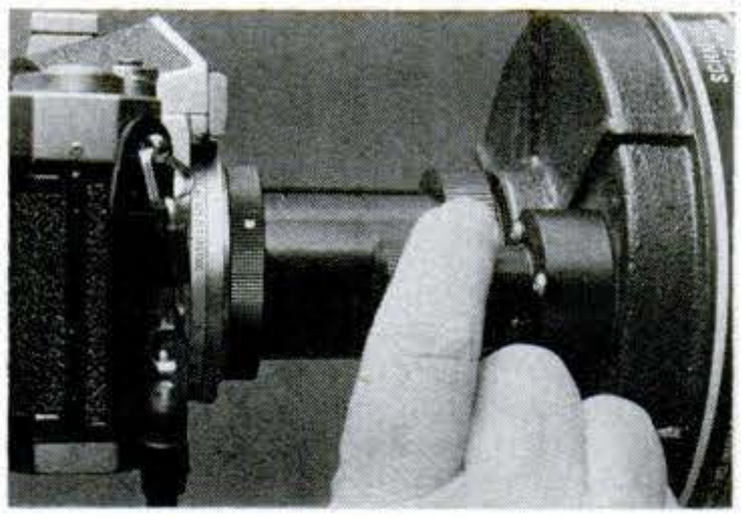
By EVERETT H. ORTNER



Turning a speck into a bird

It's an experience, shooting with a 1250-mm tele lens. Objects are 25 times larger than with a normal 50mm lens—a bird that's a speck with 50mm fills the frame with 1250mm.

The telephoto I used is a Celestron mirror lens with a fixed aperture of f/10. You control the exposure by changing the shutter speed. You focus by turning a knob at the back of the lens (right). The big problem with such lenses is, of course, getting a steady mount under them. Wind, passing traffic, even a heavy hand on the camera or shutter release, will affect picture sharpness. You need a good tripod and patience (to outwait that truck going by).



The Celestron 1250 weighs an amazingly light four pounds. With carrying case, it's $495 (plus $10 for adapter ring). A companion 750mm lens is $445. The maker: Celestron Intl., 2835 Columbia St., Torrance, Calif. 90503.

Versatile tripods

Want to take a low-level shot with your camera only six inches off the ground? Remove the center-column assembly of the Slik tripod at bottom left and replace it with a low-angle post. Uneven terrain? The legs lock at odd angles to accommodate. And everything—legs, pan head, elevating column—is removable and interchangeable. Indeed, the Slik is really a support system rather than a single tripod. For special uses where you don't mind spending a few minutes to set up (with an Allen wrench), these tripods are as slick as their name. They're imported from Japan by Berkey Marketing Companies, Inc. (Box 1102C, Woodside, N.Y. 11377).

The little tripod to the right of the Slik is a new multi-position Gitzo. It's a cutie, too. Legs spread so you can use it all the way down to floor (or tabletop) level, and it tilts for such uses as copy work and titling. Gitzos come in a range of sizes and prices (starting at $79.95) and are imported from Switzerland by Karl Heitz, Inc. (979 Third Ave., New York, N.Y. 10022).

Saving old exposures

Have you ever felt the shock of looking at the frame counter of your camera and discovering that, although you hadn't used the camera in a long time, there was live film inside and—worse—that it had been exposed? Yes? Well, it's even more of a shock when you know those exposures were made 13 years before.

I had that shock recently when I looked in the little red window of my mother's camera, saw the figure 11—and

realized that she hadn't used the camera in the 13 years since she had taken it to Europe on a vacation trip. Luckily the film was black and white (Verichrome). I gave it 50-percent extra development, and it came out perfectly—no fog, no problem, although on the picture shown (a Paris sidewalk cafe), there's a tiny unclarity on my mother's face (she's the one on the left). A smear of paté on the lens, perhaps?

Thirteen years is no record, of course. A friend at Kodak tells me that they exposed and developed—with perfect results—some film cached in a Peruvian cave for about 70 years. And a photographer friend has a 17-year exposure-before-processing anecdote.

What should you do if it happens to you? Here's Kodak's recommendation for their b&w film: Develop in D-76 full strength at 68 degrees for 15 minutes, and don't forget to drop in an anti-fog tablet. PS

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The night belongs to Charger.

If your pulse quickens after dark, Charger is your car. Charger has a look that was shaped for the night. An excitement to match your mood when you've left the day behind.

Close yourself in Charger, and the dark lights up. You're hugged by high-back bucket seats. Before you, a full array of controls for night cruising. A standard 318 V8 links to the TorqueFlite automatic transmission to let you glide around all those everyday cars.

When the sun goes down and the lights come up, move into Charger time. Some of us were born for the night. Now we have a car that belongs to us... Charger. Get one at your Dodge Dealer's.

'77 Dodge Charger

Dodge

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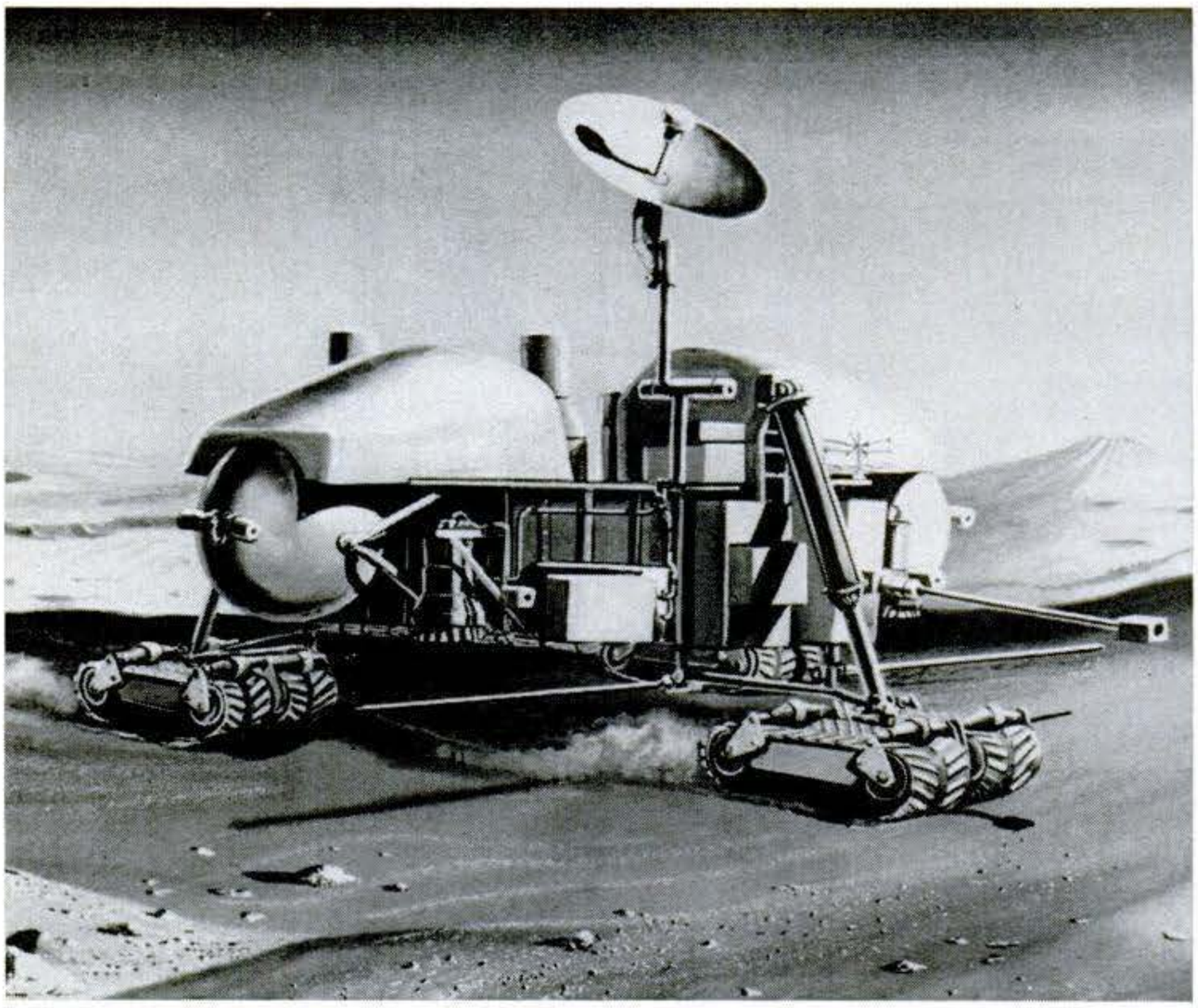
SCIENCE NEWSFRONT

BY ARTHUR FISHER



Martian rover

"If only we could move it to that beautiful rock over there . . . if only we could get on top of that hill to see over it . . . " That's the lament of the scientists managing the successful Viking missions to Mars. For although the landers are performing superbly, they are rooted to their landing sites, and so their reach is severely limited.

The solution, for future missions to Mars or other planets, may be the vehicle concept shown here, developed by NASA's Marshall Space Flight Center, and called the Elastic Loop Mobility System (ELMS). An elastic-loop track would replace each of the three landing pads on the present Viking landers, distributing weight uniformly over a large surface area and combining the suspension and drive systems of the craft into one compact, lightweight module.

A study by the Viking Project Office at Langley, Va., with experts from Marshall, the Martin-Marietta Corp., and Lockheed, concluded that it is technically feasible to meld the ELMS concept to a third, backup Viking lander. The result would be a roving scientific laboratory able to range the Martian surface for six months at a time, over distances of up to 90 miles. A future planetary rover with ELMS might run for two years with a range of 300 miles.

Ultraviolet detector

The infant science of ultraviolet astronomy has matured some with the acquisition of this reflector system, part of the most sensitive detector of extreme ultraviolet radiation ever built. (See photo, lower right.)

Such radiation has higher energy than normal UV, but less than X rays. Astronomers think it may be emitted by white dwarfs (stars nearing the end of their life cycles); from the coronas of ordinary stars, such as our sun; and perhaps from giant stars 10 times larger.

The first observations of extreme UV from outside the solar system were made under the direction of the Astronomy Department at the University of California at Berkeley, during the joint US-USSR Apollo-Soyuz manned space mission. The new detector, built at Lawrence Livermore Laboratory, uses a gold coating two-millionths-of-an-inch thick to enhance its reflectivity, and thus its UV light-gathering ability. The new system is 100 to 1000 times more sensitive than previous designs. It will make its observations from rockets lofted above the Earth's atmosphere.

Smoke screen

Did you know that the old reliable smoke screen of days gone by is valueless against many modern weapons systems? That's because projectiles can now be aimed with the help of infrared rays, which "see" through normal smoke. (The same principle allows firemen to use infrared scanners to spot hot spots through dense smoke.) Now, however, the Swedish National Defense agency has devised a smoke that is opaque to infrared, and can be used to camouflage ships, tanks, and the like from enemy attack. The Swedes have released no details concerning the chemical composition of the smoke. Maybe they have something to hide?

Fastest computer

The world's fastest computer, the only one of its kind in existence, is now running at full capacity at the National Oceanic and Atmospheric Administration's Geophysical Fluid Dynamics Laboratory in Princeton, N.J.

Called the "Advanced Scientific Computer," it is being used to hack away at one of man's most difficult problems: understanding and predicting weather and climate. Built by Texas Instruments, the new computer can perform 50-million additions per second, two to five times faster than any previous computer, according to James Welsh of NOAA. Its central memory can store one-million words. This enormous capacity is essential if weather-prediction problems are to be solved in a short enough time for the results to be useful. It does little good to learn what next weekend's weather will be if you don't get the answer until next month.

Tilting the climate

Over the last million years or so, vast sheets of ice have periodically advanced and retreated over the face of the Earth. Geologists have long postulated that changes in the Earth's orbit, which could have altered the amount of solar energy reaching its surface, might have regulated the waxing and waning of the

Continued

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RALEIGH

Warning: The Surgeon General Has Determined That Cigarette Smoking Is Dangerous to Your Health.

Raleigh's good time gifts. Get a Norelco electric shaver with Raleigh coupons, the valuable extra on every pack. See over 1,000 Raleigh gifts, write for your free Gift Catalog: Box 12, Louisville, KY 40201.

You'll remember Raleigh. The genuine tobacco flavor. The valuable gift coupons.

Filter Kings, 16 mg. "tar," 1.1 mg. nicotine; Longs, 17 mg. "tar," 1.2 mg. nicotine, av. per cigarette, FTC Report Apr. '76

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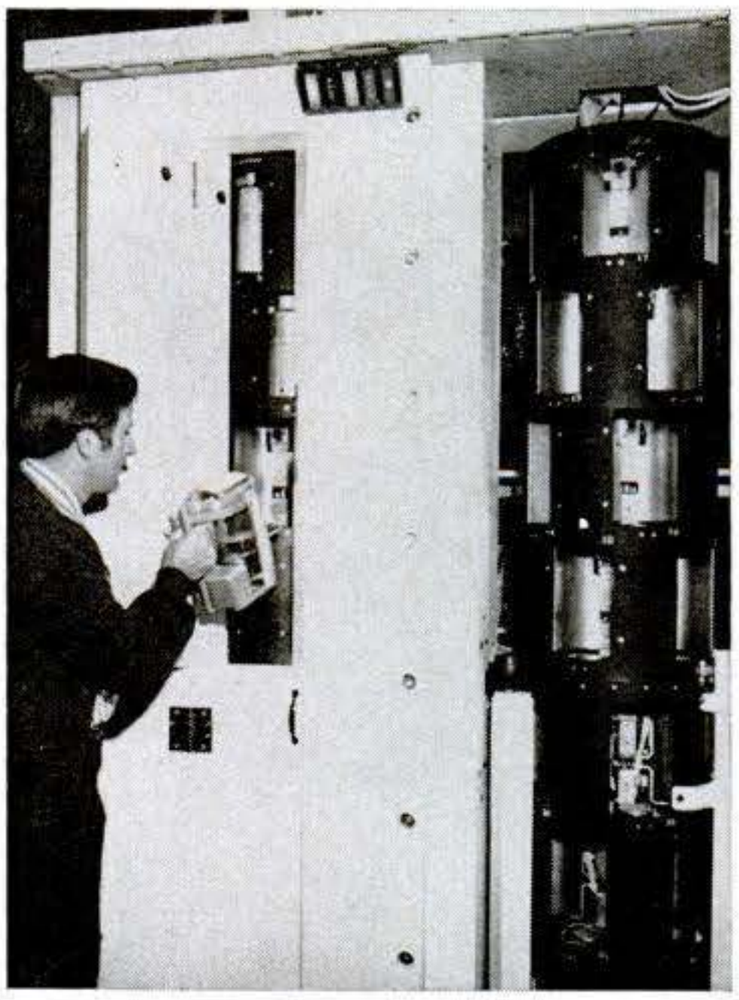
[*Continued*]

Ice Ages. Now a team of American and British scientists report the first statistical evidence for this theory, evidence wrested from the bottom of the sea.

Dr. James D. Hay of Columbia University's Lamont-Doherty Geological Observatory, Dr John Imbrie of Brown University, and Dr. Nicholas J. Shackleton of Cambridge University in England based their conclusions on a study of sediment samples obtained from deep-sea cores, which provided a half-million-year record of the Earth's geological past. They found clear indications of climatic cycles of 21,000 years, 42,000 years, and 100,000 years. These correspond precisely to the cyclical variations in the Earth's tilt, wobble, and orbital path, respectively. Based on their analysis, the scientists project (ignoring the possible effects of manmade climatic changes) a coming time of "extensive glaciation" for the northern hemisphere over the next few thousand years. Their research was supported by the National Science Foundation.

Nuclear safeguarding



The question of keeping dangerous nuclear materials—especially those that might be used to assemble an atomic bomb—out of the hands of terrorists, extortionists, or just plain lunatics, is of mounting concern. The device you see here, looking something like an overgrown coin-operated food dispenser, is part of one answer to the problem. It's a storage vault, using eight-foot-high carousels housing canisters that contain up to 2½ kilograms of so-called special nuclear material, a polite euphemism for plutonium, highly enriched uranium, and other risky substances.

Developed at Sandia Laboratories, for ERDA's Division of Safeguards and Security, the system works like this: Before anyone can enter the vault to remove material, his authorization must be validated by a security-operations center, a materials-operations center, and a materials-accountability center. The three centers are located in separate areas and manned by separate staffs. A system that matches photographs, fingerprints, or signatures—using computer techniques for automatic comparison—will be used. Sensors at the vault entrance will detect contraband, such as explosives, tools, or weapons.

Inside the vault are the steel carousels, each containing 35 canisters. They have geometrically spaced openings that operate in conjunction with doors, via remotely controlled locks. Computer-controlled from the materials-operations and materials-accountability centers, the carousels will turn to a predetermined position, making the prescribed canister available through a door that unlocks only at the appropriate time. Only one canister is accessible at a time. The contents of the canisters and the carousels are constantly monitored and inventoried. Any discrepancies are immediately reported to the control centers. If everything is in order, the visitor is permitted to leave the vault.

Gold tester

How much gold is there really in that "solid gold" bar you found in your great-uncle's attic? Now there's an inexpensive, simple, small, nondestructive, fast, accurate, and foolproof device to test the purity of gold objects. Invented by Dr. Ogden H. Hammond III, a researcher at the Massachusetts Institute of Technology, the tester works by applying heat to one end of a gold bar and measuring the temperature at a specific distance from that point. The device will detect a temperature pattern that varies with time, and compare it to a standard pattern for gold of known purity. If the piece being tested doesn't measure up to the karat standard, an alarm goes off, giving you the bad news.

Atmosphere sniffer

The Learjet aircraft pictured below sports two advanced meteorological instruments as part of a program to sample our atmosphere. Together with wing-mounted devices, they will determine how much liquid water and snow is contained in clouds up to 45,000 feet high. The research is sponsored by the Geophysics Laboratory of the Air Force Systems Command. PS

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ADVENTURES IN ALTERNATE ENERGY

A monthly sampling of projects PS readers have devised to conserve or replace fossil fuels

Stephan Sieradzki: Windmill on a boom

By EDWARD MORAN

Someday in the not-distant future, Steve Sieradzki hopes to take his windmill along on a fishing trip. A flexible tower similar to the one pictured here will be mounted on the roof of his van. When he arrives at his favorite fishing spot, he'll raise the 10-foot prop skyward and fill ballast tanks with water to stabilize it. The power generated—400 watts in a 15-mph wind—will be used to cool the beer and cook the fish, he says—quite an energy-saving angle.

Although Sieradzki hasn't yet built this mobile unit, he has created a novel DIY windmill at his Fairdealing, Mo., home. Unlike most rigs, it's not mounted on a fixed tower, but on a flexible boom that rises and falls with the wind—for safety, efficiency, and ease of maintenance.

Anyone who's ever handled a spinning windmill, from the tiny water-pumpers on the plains to the giant NASA/ERDA job at Sandusky, knows the importance of speed control: A rig can rip itself to pieces if the blades overspin in a strong wind. And faster doesn't always mean better when it comes to generating power. Further, mounting the propeller atop a 20- to 60-foot mast means the milltender has to shinny up to dizzying heights every time anything needs attention.

"Why not bring the prop down to the ground, and solve both problems?" Sieradzki reasoned. So he designed a windmill on a boom like that of a hoisting crane and balanced it by counterweights (here, rocks in wooden boxes), so that the prop is lifted to its maximum height and automatically adjusts to face the wind.

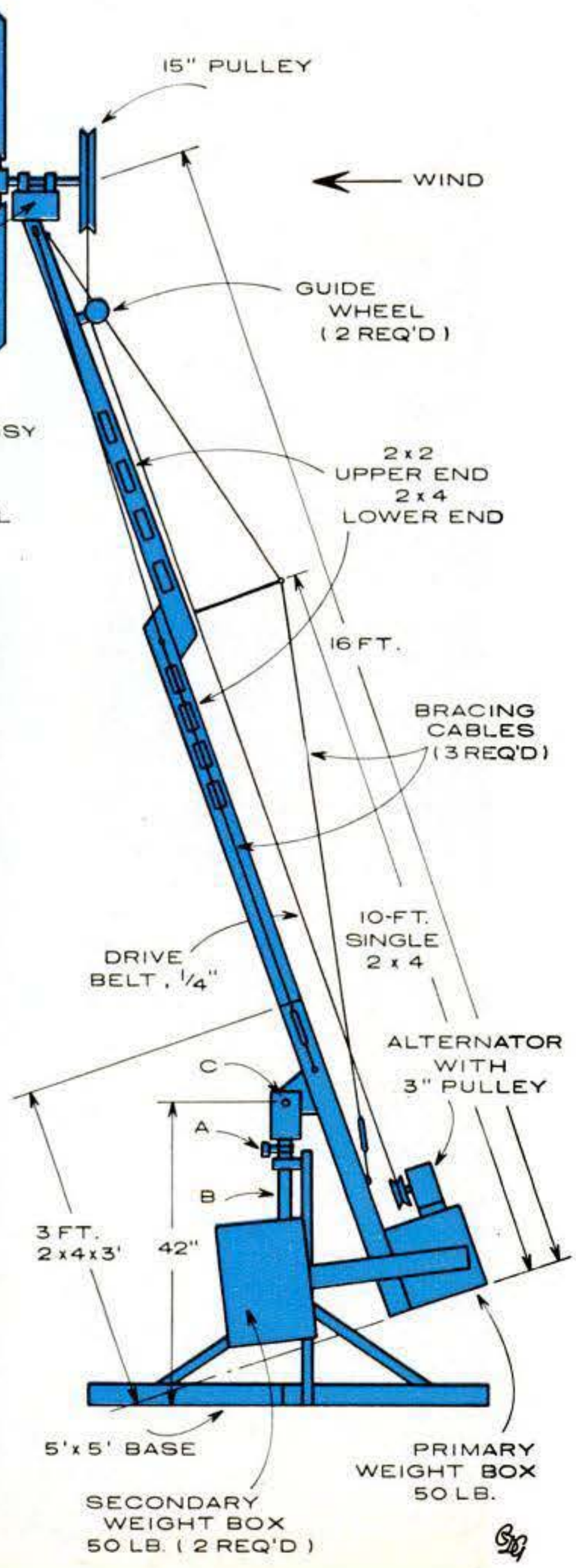
"I use very light construction braced by steel cables and mounted on a base similar in operation to an antiaircraft gun mount," he says. "In fact, a German 88mm mount would make an excellent base for a 50-foot boom."

When the wind blows . . .

The leaning tower is almost vertical in winds up to a preset limit (say 25 mph), and the prop faces squarely into the wind. Above this limit, however, the wind overcomes the counterweights and pushes the boom over, downwind and closer to the ground. This tilting of the shaft reduces the area of the spinning propeller that faces the wind, thereby preventing rpm from exceeding dangerous limits. Pressure on the structure is also reduced, permitting lighter construction.

"Present rigid towers," the inventor points out, "must be designed to take the highest wind force for their area—a force that occurs rarely or never." When such a blast does come, Sieradzki's prop will be lowered to within 10 feet of the ground, where it will stay until reset at its operating height after the storm—a further protection to the equipment.

Built principally of recycled ma-



Flexible-boom windmill is designed to "lean" in high winds, preventing dangerous overspinning. The propeller assembly can also be brought down to the ground for easier maintenance. Unit disassembles easily for storage and moving. Inventor Sieradzki plans to mount smaller mobile unit atop his van.

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terials, the windmill-on-a-boom cost Sieradzki about $75. He obtained the alternator from a junked car, and used shock absorbers from an old truck to cushion the boom and prevent it from slamming into the swing-limiting stops. For the drive belt, he recommends using round polyurethane belting because it's extremely tough, yet elastic enough to keep the belt under proper tension.

A store-bought propeller can be costly; Sieradzki made his of 0.032″ fiberglass sheet. It weighs but 3½ lb., a boon because it keeps the rig from becoming top-heavy and makes the prop more responsive to changes in wind conditions. One warning if you decide to build a windmill of this type: A prop spinning at 300 rpm is a lethal weapon; you won't want it to come down closer than 10 feet to the ground, hence the swing-limiting stops mentioned earlier.

Generating electricity

Sieradzki's primary goal was to test a novel design, and he admits that the power output of the device could stand improvement. By using a 5:1 stepup belt drive, he obtains 200 watts at 12 volts in a 15-mph wind.

The generator is located near the lower end of the boom; power is transmitted from the prop and removed via slip rings at the base.

Steve Sieradzki plans to make further refinements of his concept (when he's not working on a solar-powered engine that also occupies much of his time). He thinks his idea can be adapted to large-scale applications, such as in populated areas where there might be aesthetic objections to rigid towers; he envisions an array of "invisible" windmills that could be deployed automatically at night or during high winds.

To ask a specific question, send a stamped return envelope to Stephan Sieradzki, P.O. Box 81, Fairdealing, Mo. 63939. PS

Your idea may bring you $200

Each month, we'll present a project developed by a PS reader and pay the inventor $200. Ideas not suitable for this series might be purchased at regular rates for use elsewhere in the magazine.

To enter, send us black-and-white glossies (one photo should show you demonstrating your device) plus pertinent text and sketches. Write your name, address, and Social Security number on each item. No material can be returned unless you enclose a stamped, self-addressed envelope.

Since space won't permit us to present projects in detail, we'll expect inventors to answer any reasonable query from readers, if it's accompanied by a stamped envelope.

Mail entries to Energy Adventure, Popular Science, 380 Madison Ave., N.Y., N.Y. 10017.

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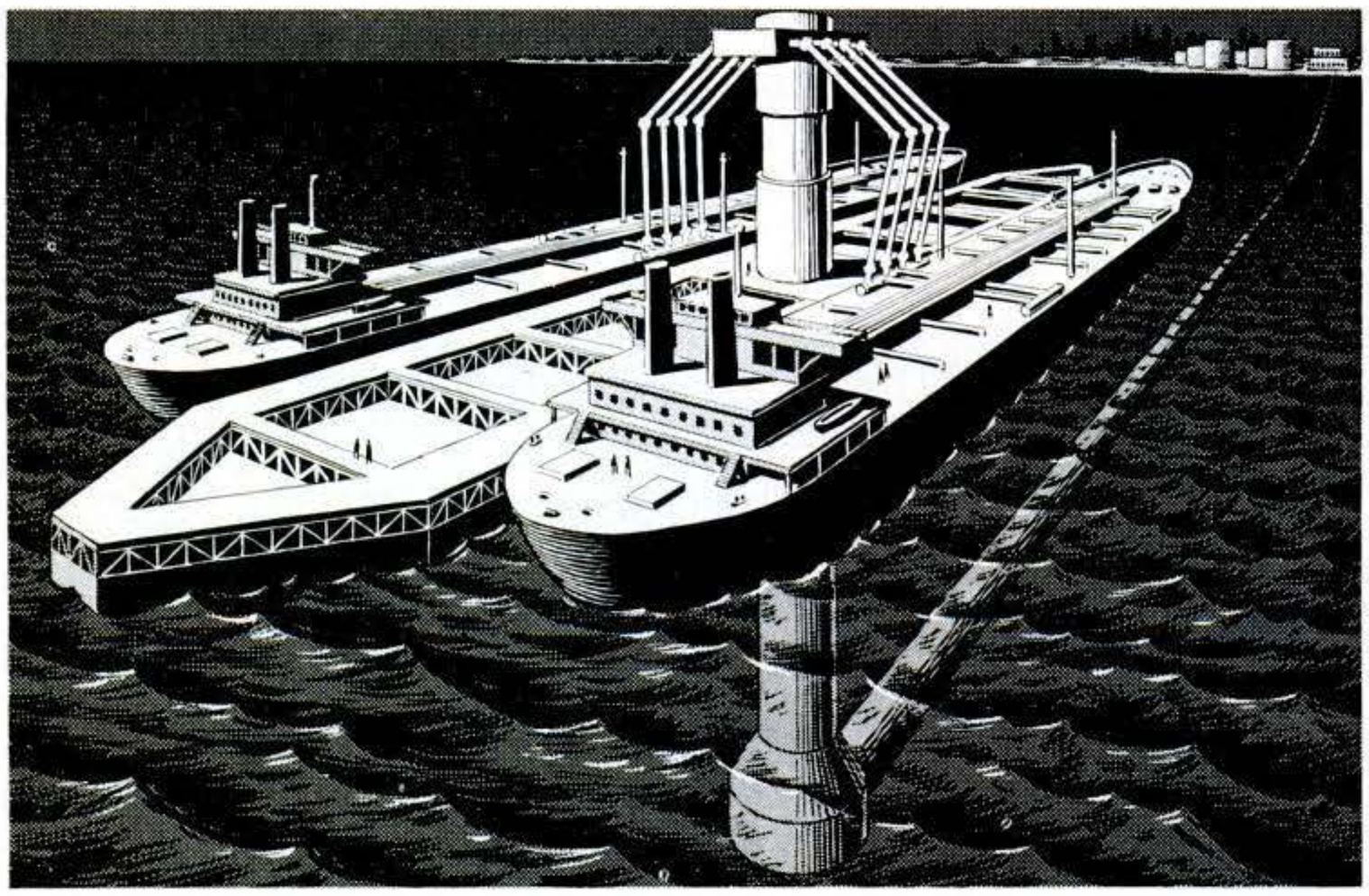
NEW IDEAS FROM THE INVENTORS

ILLUSTRATIONS BY RAY PIOCH

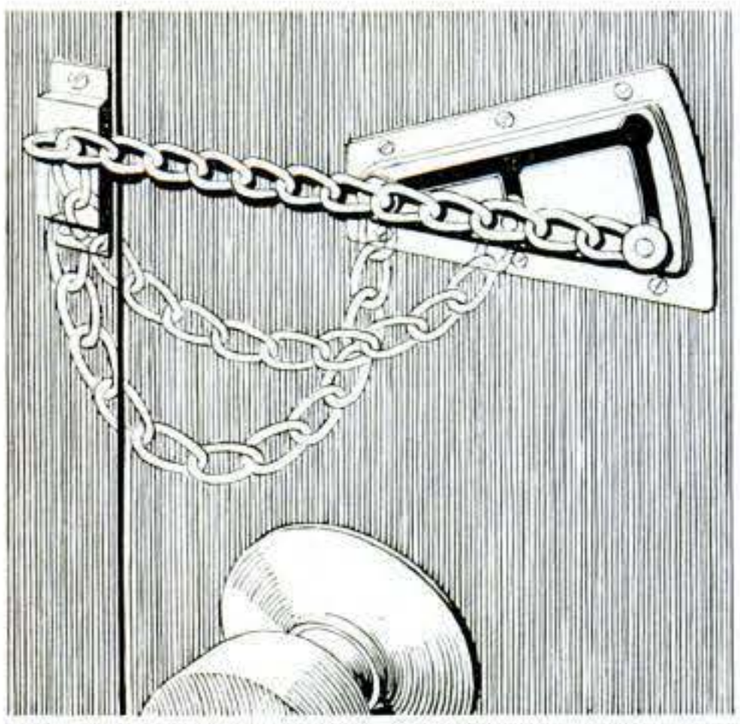


Offshore berth and tunnel system unloads giant tankers

Oil carried to all U.S.—and most foreign—ports must move in relatively small tankers because harbors can't accommodate deep-draft vessels. This offshore-transfer system might permit wider use of modern, more economical giant tankers, protect shore areas from some spill and traffic hazards. A pontoon-supported mooring tower would berth tankers in deep water even in moderately severe seas, pump cargo ashore through a submerged tunnel.

Car light monitors coolant

You wouldn't have to wait for your engine-overheat indicator to show you that something was wrong with your car's cooling system if you had electrical contacts like these in the wall of your auxiliary coolant tank. When the contacts were submerged, current would flow through a normally-off relay. If the fluid level dropped, however, a dashboard light would alert you.



Chain spacers help secure door

By selecting from several slot positions, you could completely lock a door held by this chain, open it just a crack to peek out, or pull it slightly wider to accept a letter or small package. When the chain was slotted in its tightest, fully-closed position, it could help to prevent a lock-picking intruder from snipping or snapping the chain.

Fire unlocks emergency door

Smoke and heat sensors in this emergency escape system would open normally locked doors at the first sign of danger, then turn on flashing lights and sounders to guide people in a building to the quickest way out. After a timed interval for escape, the system would close (but not lock) the doors to isolate the burning area.

Clip-on cleat fights skids

With two pivoted strips flanged to grip the sole of your shoe, and an elastic band to grip the heel, this cleat would snap on quickly when you wanted to improve your traction on snow, ice, or other slippery surfaces. Quickly removable, too, the steel ground-gripping strips could be shaped for effective, long-lasting traction.

The following patents have been issued on these inventions: **Offshore berth**—No. 3,950,805 to Christopher J. Murphy, Douglaston, N.Y.; **Chain lock**—No. 3,920,273 to Herman J. Scholtze, Berkeley, Calif.; **Fire door**—No. 3,818,635 to Yoshio Morita, Japan; **Coolant light**—No. 3,832,982 to Helmut Guehr, Ruthdale, W. Va.; **Cleats**—No. 3,834,045 to Clarence J. Crigger and Ralph S. Arbogast, Rittmann, Ohio.

Copies of patents may be ordered, by number, from the Commissioner of Patents and Trademarks, Washington, D.C. 20231, at 50 cents each. To write to an inventor, if address above is insufficient, address him by name and patent number in care of the Commissioner.

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15 mg. "tar," 1.1 mg. nicotine, av. per cigarette, FTC Report Apr. '76

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BOATING BEAT

By BOB BLACK

Whaler spawns a Harpoon

Boston Whaler, which has concentrated with such success on light powerboats, now has introduced a sailboat—the Harpoon 5.2 (that's meters for a 17′ overall length), the first of a new line of sailing craft (left, above).

With a comparatively large cockpit and a 7′5″ beam, Harpoon can carry 160 sq. ft. of sail (jib, 52 sq. ft.; main, 108 sq. ft.). She draws 3′8″ with the board down, 4½″ when it's up. Weight is comparatively light—400 pounds. She is made with the same foam-sandwich construction as Whaler powerboats.

Designed by C&C, outstanding in sail boats, and built by Whaler, this could be a real winner.

Chrysler and Herreshoff team up

A nice looking, trailerable, six-berth cruising sloop (the Chrysler 26—right, above) has been designed by Halsey Herreshoff with an eye for family cruising, but with enough gear to make it competitive.

Herreshoff, a yacht designer of note from a family of yacht designers of note, was the navigator on the America's Cup defender *Courageous* in 1974. He has designed the new boat with a choice of keel centerboard or fixed keel.

The 26 has 6′ head room in the cabin, and sleeps her six people on forward V berths, twin single side berths, and a double stern berth located under the cockpit. The portable head is enclosed.

She comes with full rigging, running gear, and other sailaway equipment as standard.

Chrysler is also adding a 14½′ planing-hull performance sailer and has redesigned and appointed its 15′, 16′, 17′, and 18′ bowrider powerboats for the 1977 line.

Ladies be slippered?

In December, I noted that the U.S. Power Squadrons had anchors firmly imbedded on the question of women becoming members ("Ladies Be Seated?") and that it would probably be years before the first woman skipper is piped aboard.

Now comes a press release from Edey & Duff of Harbor Road, Mattapoisett, Mass., telling of a group of female boating writers who competed in 7′6″ "Lady Slipper" dinghies for the "Every Day is Ladies' Day Race." These boats, prattles the release, are expressly designed for, and are marketed to, women.

This silliness is another setback for women in boating and the nine participants should have known better.

Fiberglass pinholes

"Pinholing" (small blisters on fiberglass gelcoat surfaces) can be remedied by the use of Polypoxy Undercoater White, according to its maker, Pettit Paint Co.

The company says tests show that washing a well-sanded hull with #120 thinner and coating by brush and roller with a 2:1 ratio mix of #4169 Part A and #4207 Part B will seal off the tiny flaws, which are bridged by the high pigmentation and epoxy adhesion. (Cure for a day, then apply antifouling or topside finish coats.) Undercoater White may also be used on ferrocement hulls as an initial primer; it won't be affected by the free alkali in the curing cement mixture.

Short takes

● A new 72-page booklet, "How to use Your Marine Radiotelephone," is designed to help boatmen, fishermen and other mariners in the proper use of this equipment. Input came from manufacturers, the FCC, the Coast Guard, government agencies, U.S. Power Squadrons, U.S. Coast Guard Auxiliary, AT&T, boating writers, and professional shipmasters. Licenses, installation, selection and use of channels and emergency procedures are covered, and there's a valuable appendix for veteran marine RT users. Single-copy price is $2.50, but quantity discounts are available for educational classes or organizations from RTCM, c/o FCC, P.O. Box 19807, Washington, D.C. 20036.

● From Cartographics Corp. (Box 88, Manchester, Mass.) comes an addition to its Mini-Charts. It's the 'Course-O-Matic' plotter—a new navigation aid for cruising, racing and fishing, designed for fast, one-handed, error-free piloting in cramped cockpits. Cost is $48.50, and any five charts (which normally cost $2.75) of your choice are included.

● Each year we receive a new copy of Glen-L Boat Plans catalog of full-size patterns and frame kits. This year, naval architect Glen Witt has added material on "one-off" PVC foam-sandwich-core construction, a new runabout, a workboat, two trawlers, and six sailboats. Price of the 129-page book is $1 from Glen-L Marine Designs, 9152 Rosecrans, Bellflower, Calif. 90706.

● Du Pont has produced a 24-minute, 16mm film, "Edge on Performance," that takes a look at the boats using Kevlar 49 aramid fibers as hull-reinforcement material [see "Kevlar Boats," this issue]. The film may be borrowed by groups, at no cost, from the Public Affairs Department, Du Pont Co., 2222 Center Road Building, Wilmington, Del. 19898.

● Samson Ocean Systems has found what it calls "a new advance in fiber technology and rope engineering that will increase the tensile strength of double-braid, polyester-type ropes to 15 percent and its wear life over 40 percent." Its product, called Duron, is being used in an improved rope called Parallay Yacht Braid. The company says the breaking strength of a half-inch-diameter line with Duron will go from 7500 pounds to 8600 pounds, and that the cycles required to break the line will be increased from 598 to 953. This could be a breakthrough that is no breakthrough. PS

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SOME OF THE BEST PART-TIME JOBS IN AMERICA TAKE ONLY A WEEKEND A MONTH.

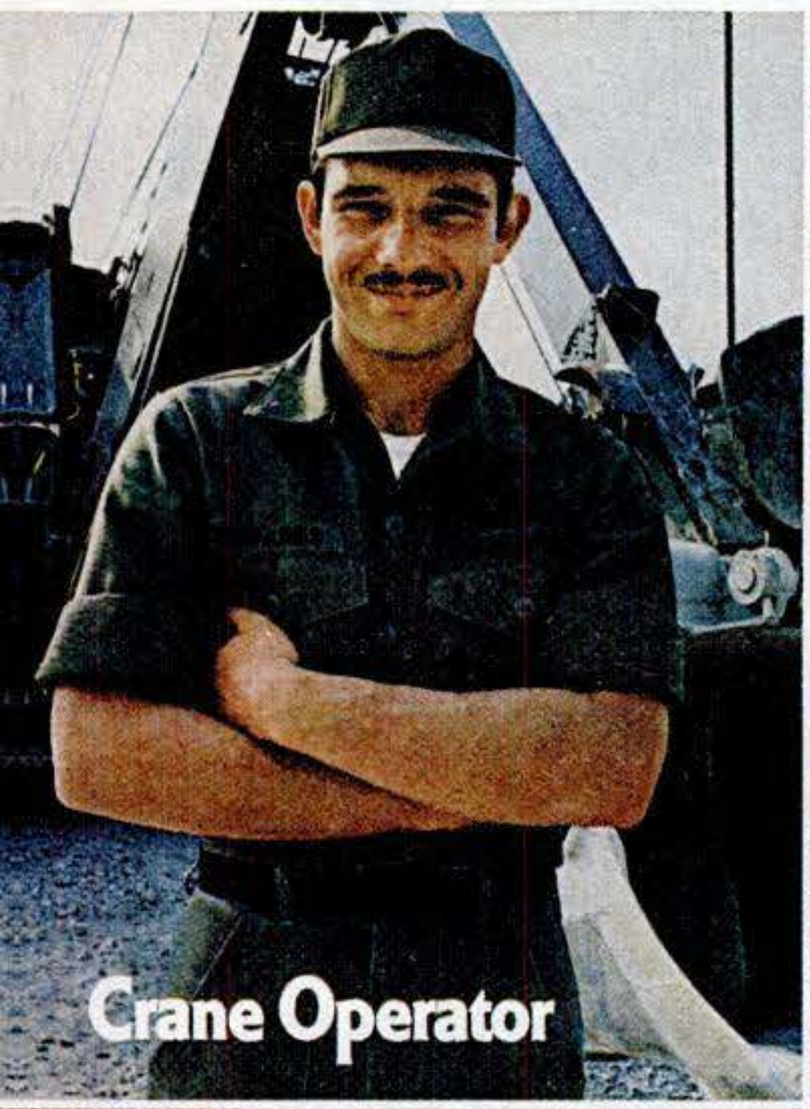
You know that enlisting in the Army Reserve is a good way to serve your country. But did you know that it's also a good way to serve yourself?

As a part-time job, the Army Reserve will give you a good second income along with more benefits-per-hour than most part-time jobs. From free job training to automatic raises to retirement income.

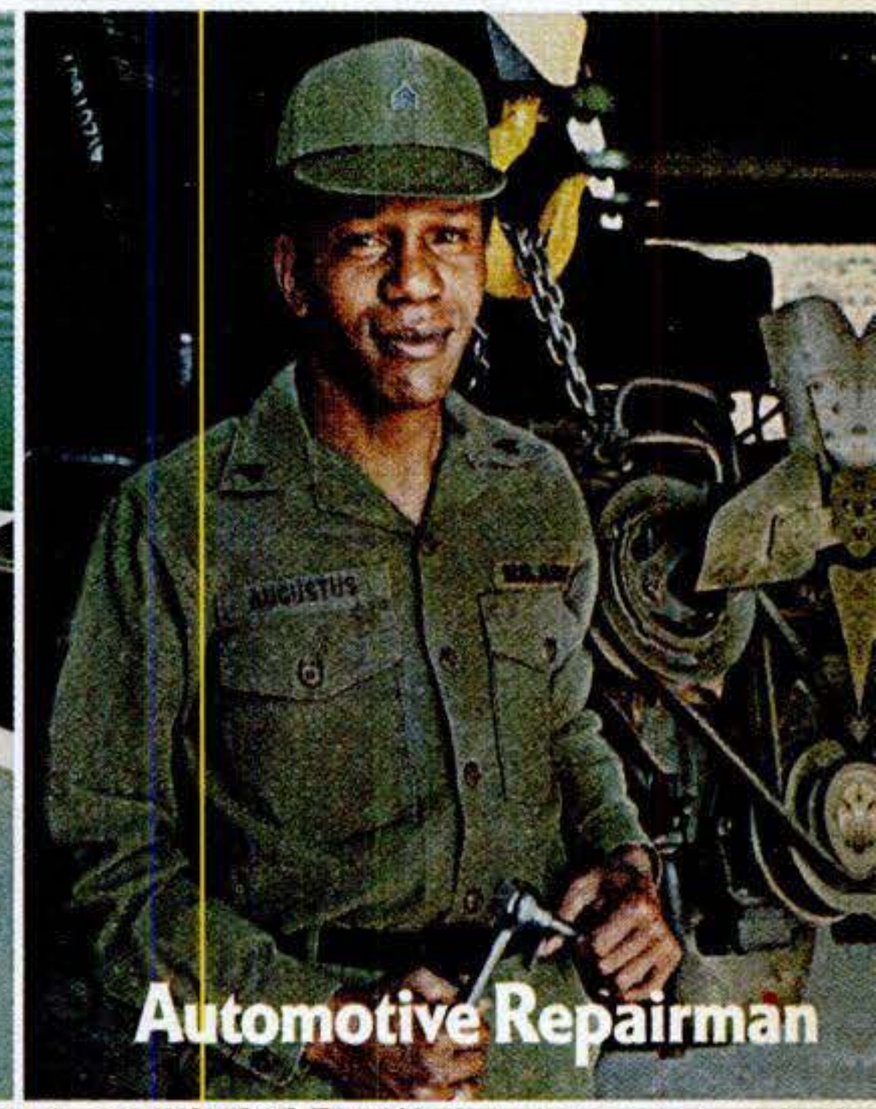
Even the hours are good. After a few months of training at full Army pay, you'll work only 16 hours a month (usually a weekend) and just two consecutive weeks during the year.

Of course, serving in the Army Reserve will earn you something that even most full-time jobs won't—the pride that comes from serving your country.

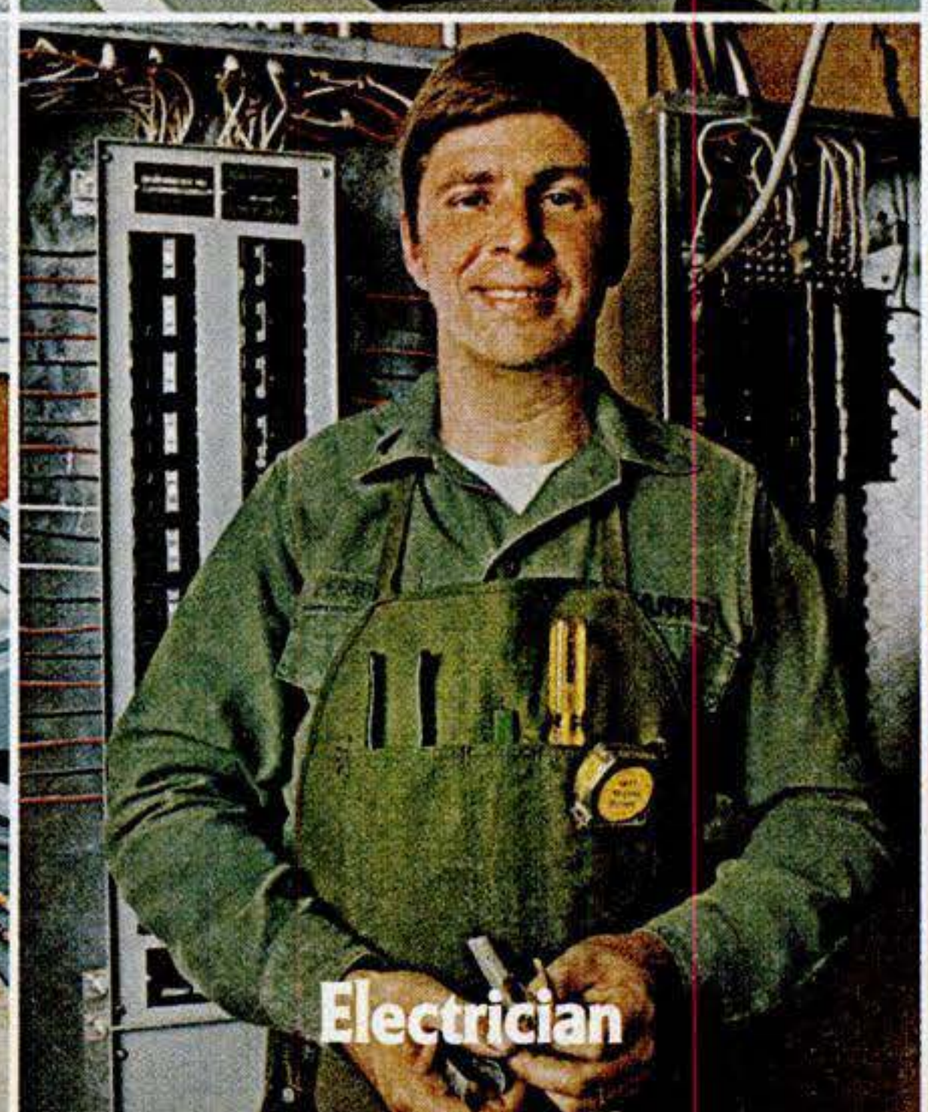
THE ARMY RESERVE. PART OF WHAT YOU EARN IS PRIDE.

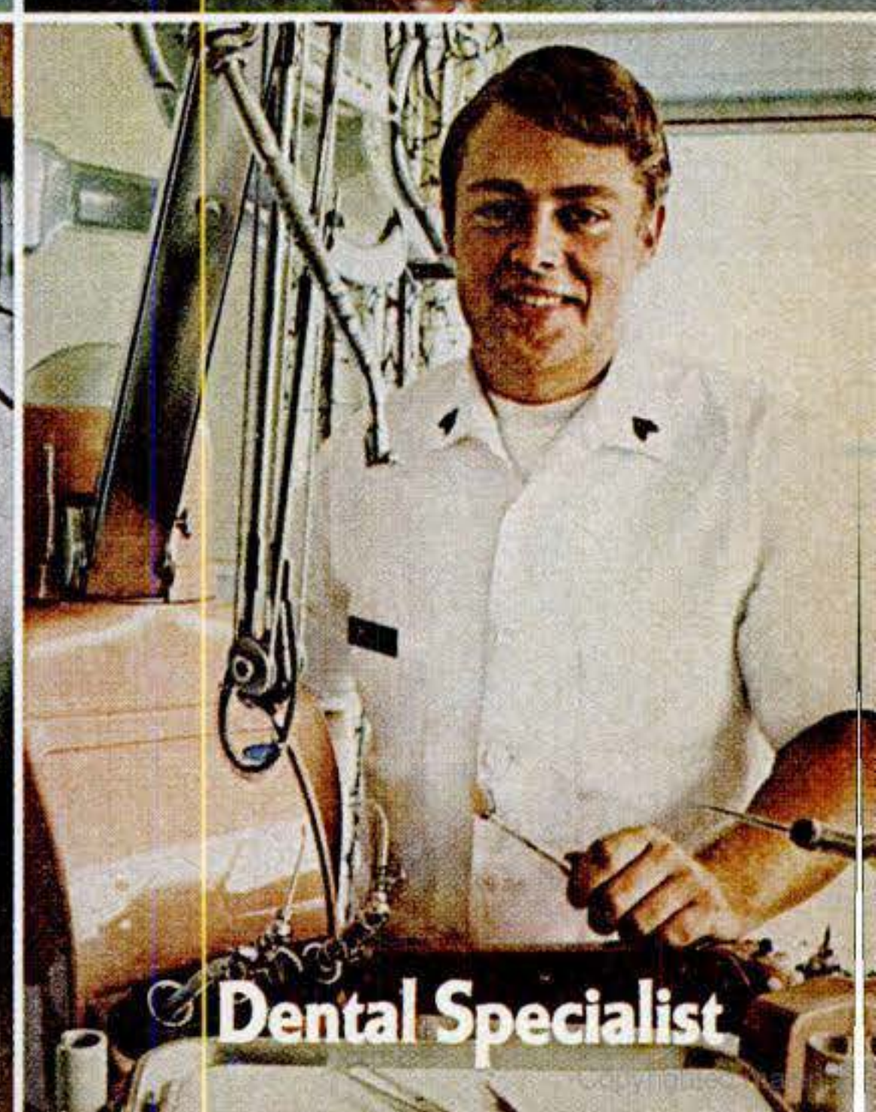

Crane Operator

Personnel Manager


Automotive Repairman

Finance Specialist


Electrician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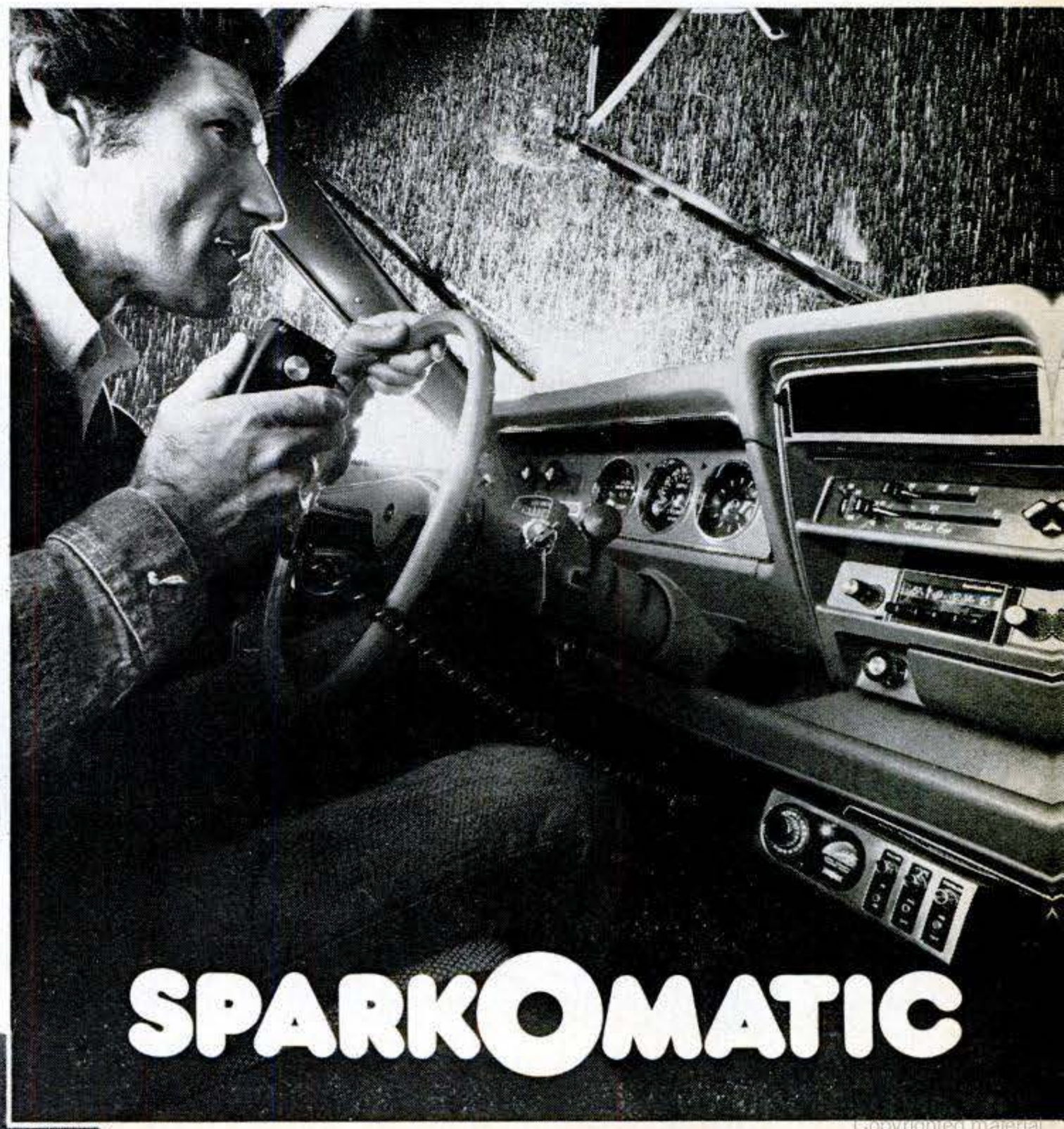

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MOTORCYCLING

By RAY HILL

Staying warm

Keeping your neck warm while street riding in cold weather can be a problem. You can wear a turtleneck shirt and a jacket that zips up around the neck, but that still leaves skin exposed to the biting air. Now there's a solution to this problem. Aptly enough, it's called Apple Warmer.

I've worn one for about 300 miles of cold-weather street riding and I like it very much. Apple Warmer consists of a layer of foam (to break the wind) and a layer of polyester fill (for insulation) sewn between two layers of nylon, the outer one waterproof. Apple Warmer attaches to the helmet with Velcro tabs, and it stays attached while you're riding. The wind won't blow it loose.

There's a side benefit, too. With a wraparound helmet, you can position Apple Warmer so the upper edge of its fabric fits in between the face shield and the helmet, greatly reducing the air leaks around the visor and onto your face.

Apple Warmer works with full-coverage helmets. It's $12.95 from Lockart Industries, Inc., 15707 Texaco Ave., Paramount, Calif. 90723. For street and touring buffs, it's a good investment.

Electrically heated vest/chaps

How about keeping the rest of you warm? For the last few hundred miles I've been fighting the problem with a padded vest and chaps that run off the motorcycle's battery.

How do they work? Well, my first ride was a 76-mile jaunt over country roads and interstate highways with the temperature in the mid 30's. I put the vest and chaps on over a pair of pants and a long-sleeve shirt. Over this I wore a snowmobile suit. If I'd worn just a snowmobile suit over the pants and shirt, it would have been a very cold ride. With my electric undies on, my chest and legs were warm. My arms were cool, though, because the vest doesn't cover them.

Next day I took the same ride, wearing the same clothes—plus a heavy sweater over the vest to protect my arms. The combination worked very well.

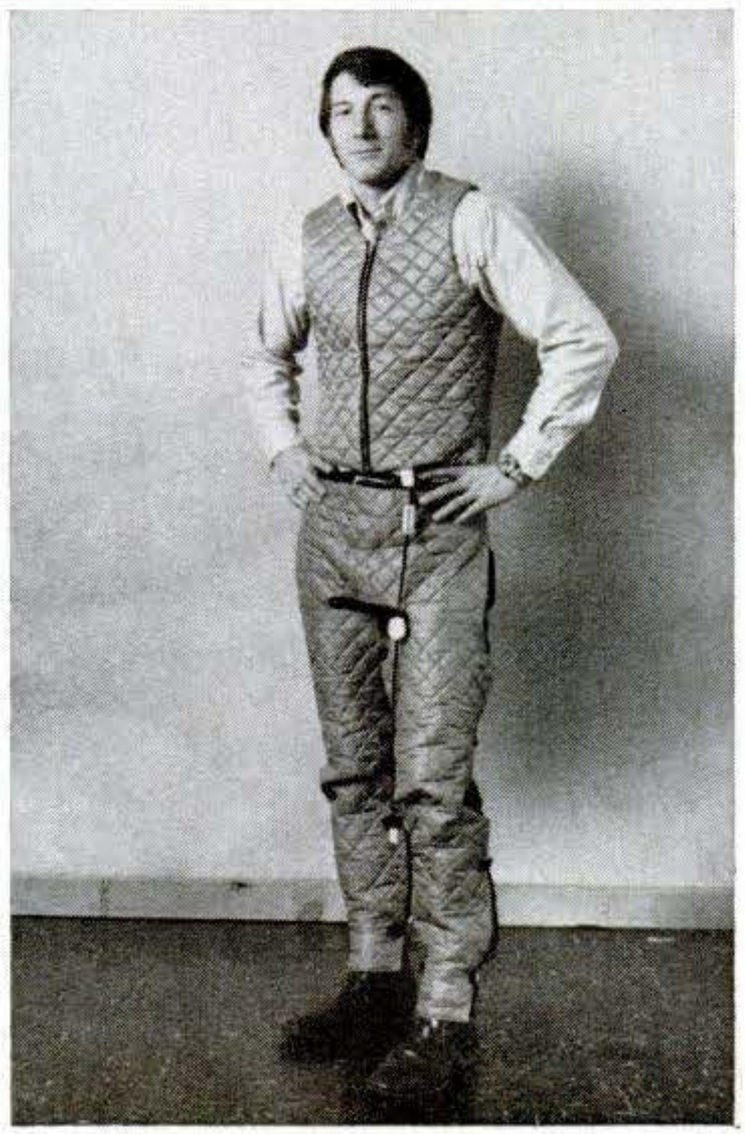
However, you're still faced with the problem of keeping your hands and feet warm.

An on-off switch lets you turn the vest/chaps off if they get too hot. In the 400 miles I've worn them, I haven't turned the switch off, but all my mileage was accumulated with the temperature in the 30's. In warmer weather, you'd turn them off occasionally.

They can also be used for nonmotorcycling activities, such as standing around in a duck blind. For this you can get a portable power pack. The vest and chaps sell for $72. For more info, write to Widder Enterprises, 3539 La Quinta, San Clemente, Calif.

About pressure testers

A two-stroke motorcycle engine is usually a pretty reliable critter. But let one develop a leak in the cylinder-crankcase area, and it can become downright cantankerous. How do you diagnose and pinpoint a leak? Well, the way a lot of people do it is to seal off the carb inlet and exhaust outlet, and pump up the cylinder-crankcase area with a pressure tester.



Then they observe the tester gauge for the rate of leakdown. If it exceeds a certain amount, say one pound a minute, they start spraying soapy water on everything till they find the leak. Nothing wrong with this method, if it works.

Problem is, some leaks don't reveal themselves under pressure. They're vacuum leaks, not pressure leaks. For example, say you've got a leaking crankshaft seal, and as the piston shoots upward it draws in not only the fuel-air mix from the carb, but also extra air through the leaking seal. This type of leak may be detectable only if you are able to create a vacuum in the crankcase. That's why you want a pressure tester that can not only pressurize the crankcase, but can also suck air out to create a vacuum.

So if you're planning to add a pressure tester to your tool collection, be sure it's a two-way unit, for both pressure and vacuum. If you can't get one from your local motorcycle dealer, you can get it from Azusa Engineering Inc., 1542 Industrial Park St., Covina, Calif. 91722.

New motorcycle tires

There's money in them thar wheels, Firestone has decided after eyeballing the growing motorcycle market—ten million motorcycles are now in use in the U.S. The big tire company plans to offer tires soon for both on- and off-road use.

Firestone says its tires incorporate advanced tread designs and the latest rubber compounds—the result of two years of testing and development. Firestone last made motorcycle tires in the U.S. in 1960.

One thing is sure: Firestone's marketing men have their work cut out for them. There are a lot of motorcycle tires available. But part of Firestone's confidence is based on a forecast annual growth in motorcycle tire sales of more than five percent during the next five years.

A word to the wise

When I was a youngster, the patches on the tubes in my bicycle tires sometimes outnumbered the fingers on my hand. That was okay, though. The bike was old, heavy, and didn't go very fast. So a flat tire, even if it happened when I was riding, was no big deal.

Unfortunately, some motorcycle riders have the same feeling about the tubes in their motorcycle tires. And that can be dangerous. If you have a flat tire on your motorcycle, don't repatch the tube, unless it's an emergency. Buy a new tube.

A new tube may cost six bucks or so, and you may get a can of patches for a buck. But why take a chance on a patch breaking loose? Your hide is worth a few extra bucks, isn't it? PS

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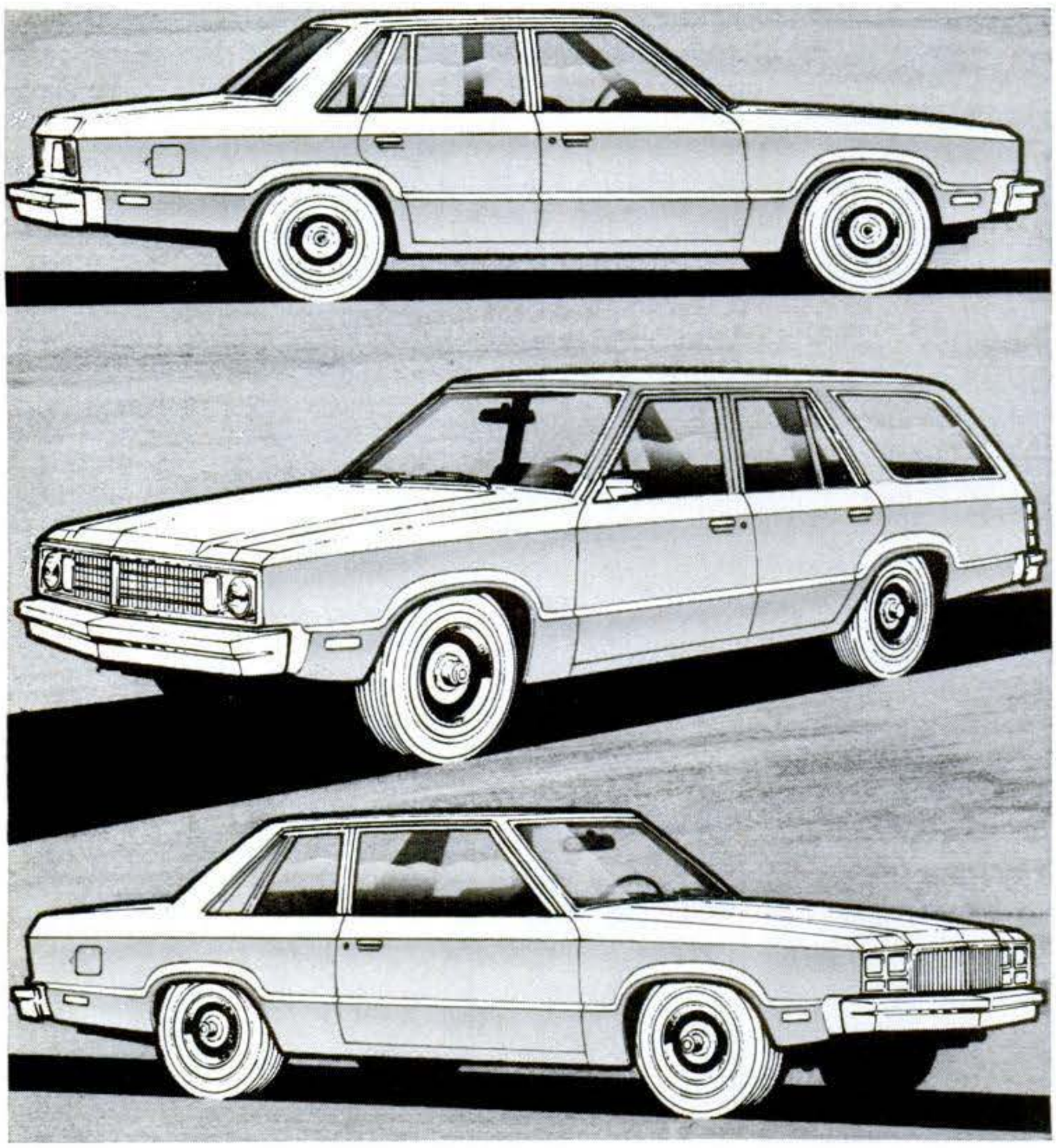
DETROIT REPORT

By JIM DUNNE



Four-headlight compacts

Look for four headlights on the Fox-Maverick compact line to be introduced by Ford next year. Rectangular headlights, set side by side, will be standard equipment, marking the first time the lighting combination has ever been used on a compact. The new line will include two- and four-door sedans, and a station wagon by Ford and Mercury.

Overall styling of all the models will be conventional, and the drive train will use the same front-engine/rear-drive axle as on today's Mavericks and Comets. However, the cars will have a distinctive shape that is easily recognizable as different from anything on the road. Boxy body lines and large expanses of glass are the two most obvious styling features. Ford plans these cars to replace the present Maverick and Comet in the 1978 model lineup. They will be sold at a lower price than Granada and Monarch.

Some imports will be smaller

That's the word from overseas, where European car firms are beginning to react to the downsizing of GM's full-size 1977 lineup. Volvo, for one, is planning to make changes in its line by the early 1980's. Other mid-size-model builders, such as Audi, Mercedes, and Peugeot, are probably making similar plans. Volvo is looking to a smaller vehicle that weighs less, uses smaller engines, and will not compete directly with full-size and intermediate U.S. models. This poses a special problem for imports. European cars right now are slimmer, lighter, and more compact than their U.S. counterparts. To cut the size and weight even further will be a tough job—but a necessary one. European car companies are terrified at the prospect of competing directly against the high-production efficiency of U.S. factories. They want their products to offer something that American cars do not. That will force changes.

Doors can be plastic—if

A study by Owens-Corning shows that a fiberglass-reinforced plastic door for a two-door coupe could weigh 43 percent less than a steel door. That's a very attractive option for car designers trying to cut down on body weight. Lighter weight means more miles per gallon—and that is important in Detroit these days. Owens-Corning says a plastic door would weigh 37 pounds, compared to 66 pounds in steel, a saving of 58 pounds per two-door car. The iffy part is that production methods must be adapted from those methods proven only in the experimental stage. A detailed analysis was made of 25 domestic and imported car doors; the conclusions assumed that the same window glass and raising mechanisms would be used in both types of doors.

Volvo calls it Lambda Sond

This is the three-way emission-control system that startled the automotive world last summer when details of its exhaust-clean-up power were announced. Lambda Sond—roughly it means "ideal engine-operation sensor"—consists of two major parts, a feedback loop added to the fuel-injection system, and a three-way catalyst. The catalyst uses platinum and rhodium to take care of all three critical emission gases: hydrocarbons, carbon monoxide, and oxides of nitrogen. Lambda Sond adjusts the engine speed and power to the optimum setting for catalytic clean-up. It holds the engine to this setting through most driving modes. In operation, the car performs normally. Power and driveability are generally not affected. Lambda Sond more than satisfies the strict California 1977 emission-control regulations, and also meets the 1978 national standards that some manufacturers say are too difficult to achieve.

Is fuel injection better?

FI may sweep the industry in the near future. Volkswagen offers it across the board in 1977, and other imports, especially those from Europe, are big users of the system. In the U.S., only Cadillac makes FI available right now, but other makers are planning to use it in their cars—Lincoln's Versailles is one. Its big advantage is in controlling emissions, but fuel economy, easy starting, and smooth operation are also pluses. Most FI designs are similar; they feature low-pressure injection that squirts fuel into the intake manifold. Combustion can be closely controlled by regulating the amount of fuel injected and the timing of the injection. PS

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Get The Lead Out. What is the grey sludge-like material that settles out of the oil drained from an automobile engine? I've heard from some mechanics that it's the lead from babbit bearings, but that can't be right as it appears in oil from newer cars without babbited bearings.

V.B.W., Parsippany, New Jersey

What you are observing is most likely lead compounds which are formed through normal combustion from the lead in the gasoline. In low concentrations it isn't serious.

'A' Is For Apple. I am familiar with the ratings (SC, SD, SE, etc.) used on motor oils. But could you please interpret the DG, DM and DS service ratings that I find on some cans? I drive a Mercedes-Benz 240D (Diesel) and suspect that these D-ratings have something to do with diesel service. Right guess or wrong guess?

G.C., Monterey, California

You're right. 'D' is for diesel. The D-rating, however, is now obsolete and has been replaced with classifications CA, CB, CC & CD which refer to oils used for commercial service in either gasoline or diesel engines. Mercedes now calls for an oil meeting CC which is Pennzoil Z-7 in either single or multi-viscosity grades.

The Old And The New. In 1966 I bought a new Datsun pick-up and drove it 198,000 miles with no major repairs. I changed my own oil every 2,000 miles, always using Pennzoil in the can with the black ring that says "Service MM-SC-CB". Last week, I traded in my old '66 on a new Datsun pick-up. The owners' manual specifies SD or SE oil. I had such good luck with the black ring Pennzoil, I don't want to change! Can I still use it in my new Datsun?

G.W.H., Lilac, California

Pennzoil with the black ring on the lid is a mild detergent oil. With your short drain intervals, sludge would not accumulate to any extent and wear would be minimal. This is why you went 198,000 miles without engine repairs. But in newer cars, particularly since 1971, engines run hotter and more contamination enters the crankcase because of emission control devices, so only an SD or SE oil (American Petroleum Institute classifications) should be used. This is a high detergent oil which will give you maximum protection and engine life. Even if you change your oil every 2,000 miles, we recommend this type of oil. Our product is Pennzoil Z-7 in either single or multi-viscosity grades, according to the engine manufacturer's specifications.

Airborne Additives. I fly a plane with a Wright Cyclone engine. The engine was completely remanufactured recently and now has about 25 hours on it using an SAE 60 non-detergent aviation oil. Can I change to Pennzoil Aircraft Oil without creating excessive oil usage?

J.F.D., Southfield, Michigan

You certainly can, and now is the time to do it. Some aircraft engine manufacturers recommend a straight mineral oil be used for the first 25 hours to seat the rings. After which Pennzoil Aircraft Oil with specially formulated ashless additives may be used.

Lawfully Leaded. I've heard that the EPA is intending to outlaw leaded gasoline by 1980. Many of us are planning to keep our present cars past 1980. Should the engine in my 1969 AMC, designed to run on leaded gas, be modified to run on unleaded fuel?

R.B., East Hampton, Connecticut

No modification is necessary. The latest EPA regulations regarding lead content of gasoline shows that by October, 1979, a maximum of 0.5 grams of lead per gallon is required. There is no mention of eliminating lead altogether. Your AMC should work quite well on gasoline with this lead content.

One Deserves The Other. I have a new 1976 Dodge Aspen with a 317 V-8 engine. What grade of Pennzoil do you recommend, and do you have any preferences regarding what filter would be best for my new Aspen?

L.A.A., Spokane, Washington

For your particular area we recommend Pennzoil Multi-Vis 10W-40, because Spokane temperatures get down to below freezing during the winter months. 10W-40 will give you the protection of an SAE 40 in summer and will also provide the fast flow properties of a 10W in cold weather. Pennzoil Oil Filters are made to Pennzoil's rigid quality specifications. For your Aspen we recommend our PZ-7.

WE'RE OPEN TO QUESTIONS about motor oils, lubricants, engines. But, you can tell *us* a few things, too. Maybe you have discovered something interesting about motor oils or lubricants. Or you have a special reason for being a Pennzoil fan. We would like to hear from you. Write to: Pennzoil Company, Research Department, P. O. Box 808, Oil City, Pennsylvania 16301. Note: sorry no pictures or material can be returned. Letters chosen for publication are subject to revision necessary for publication requirements.

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Intermediate coupes
—big-car comfort in a midsize package?

PS ratings—test report in a nutshell

The ratings are based on test results and measurements. Results should be read with the understanding that they reflect tests only on our sample cars, and that other seemingly identical cars may vary in performance. Also, weather conditions (noted in our spec table) vary from test period to test period. An excellent rating is 5 points; very good, 4; good, 3; fair, 2; poor, 1; very poor, 0.

	T-Bird	Monte Carlo	Cutlass
Fuel economy	1	1	2
Acceleration	5	5	5
Braking	3	1	2
Handling	1	2	3
Maneuverability	3	3	3
Ride comfort	4	4	3
Quietness	3	3	3
Roominess	4	4	4
Visibility	1	0	2
Entry/exit ease	4	5	5

Test cars lined up on the track at Bridgehampton Race Circuit are, front to rear, Chevrolet Monte Carlo Landau, Oldsmobile Cutlass Supreme Brougham, and Ford Thunderbird. All three give a soft, comfortable, big-car ride, while at the same time offering sporty looks.

By JIM DUNNE and RAY HILL

Midsize coupes are today's best-selling cars. And the top individual seller by far is Oldsmobile's Cutlass. Both Ford and Chevrolet promote models that compare with it, and both are anxious to take over the top spot. They pin their hopes on the Thunderbird and Monte Carlo.

The sales of Ford's midsize coupe have been the least spectacular of the three. In fact, Ford introduced the Elite three years ago to bring back sales lost to Cutlass and Monte Carlo. It was not a notable success, and Ford dropped the model this year. In its place is a completely revised Thunderbird, a lighter, better-handling, more economical car that sells for a whopping $1800 less than the 1976 model. You can now get a fully equipped Thunderbird, just like the one we tested, for a couple of hundred dollars less than the base price of the 1976 model.

How do these cars compare? For our tests we selected models with similar levels of interior trim and almost identical engine/transmission combinations. The Olds was a Cutlass Supreme Brougham with a 350-cu.-in. V8 engine; the Chevrolet was the Monte Carlo Landau, also with a 350 V8. Ford builds only one Thunderbird model. We

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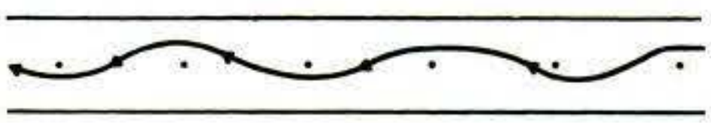

Chevy Monte Carlo winds through the PS maneuverability course. Negotiating this low-speed course brings out any major steering and suspension problems that a car may have. Problems show up as reduced speed.

Fuel mileage (mpg)

	Thunder-bird	Monte Carlo	Cutlass
Highway	18.4	16.0	18.0
City	12.7	11.4	15.2
EPA test (city)	14.0	14.0	16.0
(California, city)	12.0	13.0	14.0
Emission-control system*	C.C., A.I., E.G.R.	C.C., E.G.R.	C.C., E.G.R.

*Catalytic converter; air injection; exhaust-gas recirculation

tested a car with a 351-cu.-in. V8.

Automatic transmission, power front disk brakes, and power steering are standard equipment on all three cars. The ones we tested were equipped with a typical array of convenience and luxury items including air conditioning, stereo radios, power windows, and powered seat adjusters.

Performance and ride comfort are the outstanding features of these cars. Fuel economy and the problems caused by styling extremes ranked among their most obvious drawbacks. But that's no surprise. With this type of personal luxury car, styling and high performance are always placed ahead of more practical features.

But there has been a leveling of extremes. Fuel economy is one good example. Thunderbird, a car notorious for its poor fuel economy, achieved almost 13 mpg in city driving and more than 18 mpg in our highway test. The figures (slightly lower than the 14- and 20-mpg results reported by the EPA in its city and highway tests) show clearly that the Ford personal luxury car is no longer at the bottom of the heap in fuel economy. The gain over 1976 T-Birds is a dramatic 23 percent.

Our interest was focused on the Thunderbird, right from the start. This is a new model for 1977, and its design marks a radical change in Ford's approach to the T-Bird. The new model is about 750 pounds lighter, has a wheelbase four inches shorter, and is 10 inches shorter overall than the 1976 version. In addition, smaller, more fuel-efficient engines are available for the first time. The 351-cu.-in. V8 in our test car was not available last year. Ford also offers a more economical 302-cu.-in. V8 in the 1977 model.

Cutlass and Monte Carlo are similar in many ways. The Cutlass uses GM's A body; the Monte Carlo uses a variation of that, called the A Special. The present bodies are four years old and due for a change next year. The planned downsizing is the second step in GM's plan to build its entire line smaller, lighter, and more fuel-efficient.

Fifth wheel attached to rear of vehicle (T-Bird is shown) enables testers to determine speed of each car during braking and fuel-economy tests.

Roominess

Both the driver and front-seat passenger have plenty of leg and head room, and sit in comfortable, well-padded seats. Rear-seat passengers don't do as well. The seats are comfortable enough, but head room and knee room aren't adequate for most people. (The cars rated a 4 in our roominess category only because of their very good front-seat room.)

Entry and exit ease are also very good, due primarily to the wide doors and the access they provide to the rear-seat area. Wide doors can be a drawback, though. They are heavy and more difficult to open and close, and are especially bothersome in tight parking places where lots of swing room is necessary for a full-open position.

Our results in the interior-noise test surprised us, because we'd expected better. The Thunderbird, especially, was disappointing. In past years Fords have gained a well-deserved reputation for quiet riding. The Thunderbird's rating of 3 is a switch. Earlier Thunderbirds rated a solid 5. The deterioration probably is traceable to the new body design, particularly the lighter weight, and the generally lower level of luxury.

None of the cars will win any awards for driver visibility. Blame that mostly on styling. Each of the

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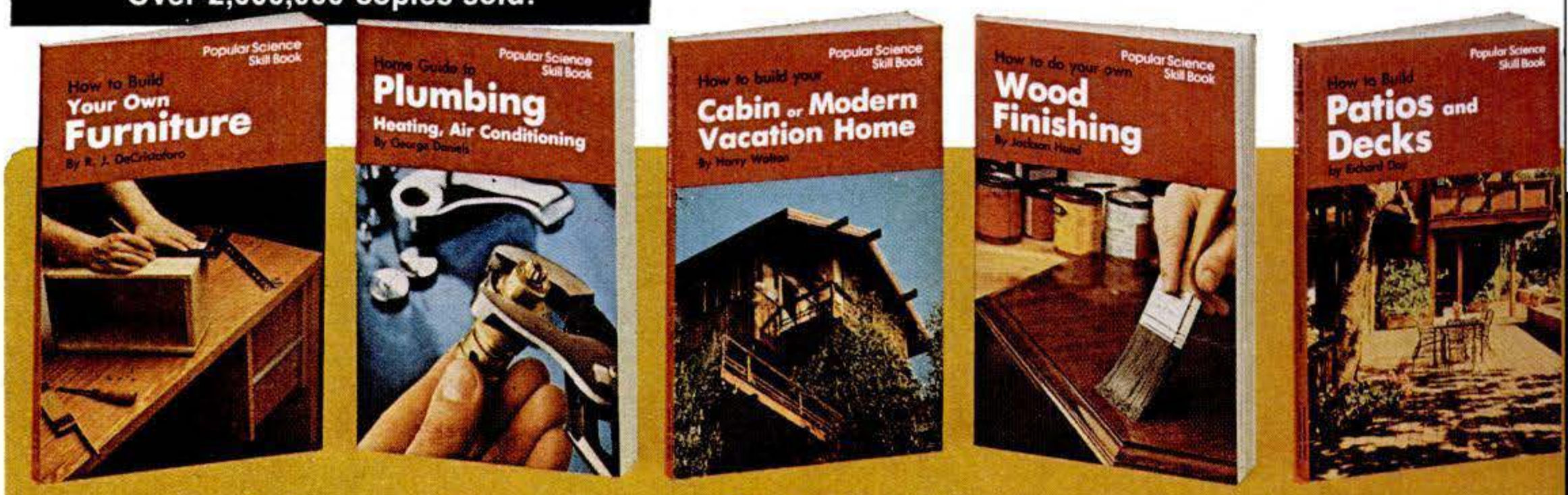

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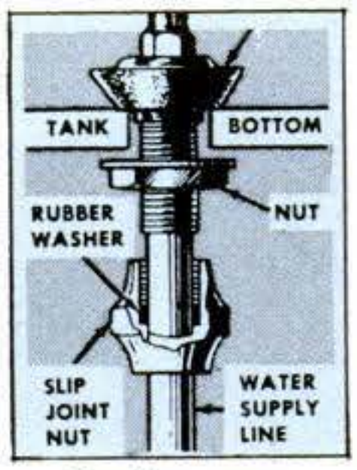

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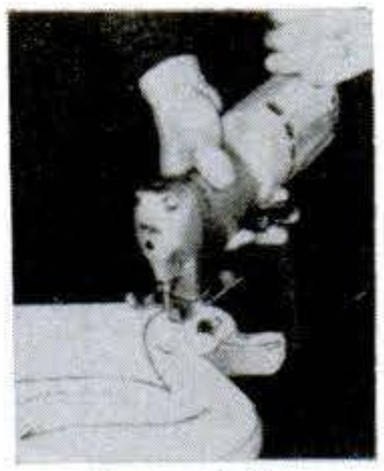

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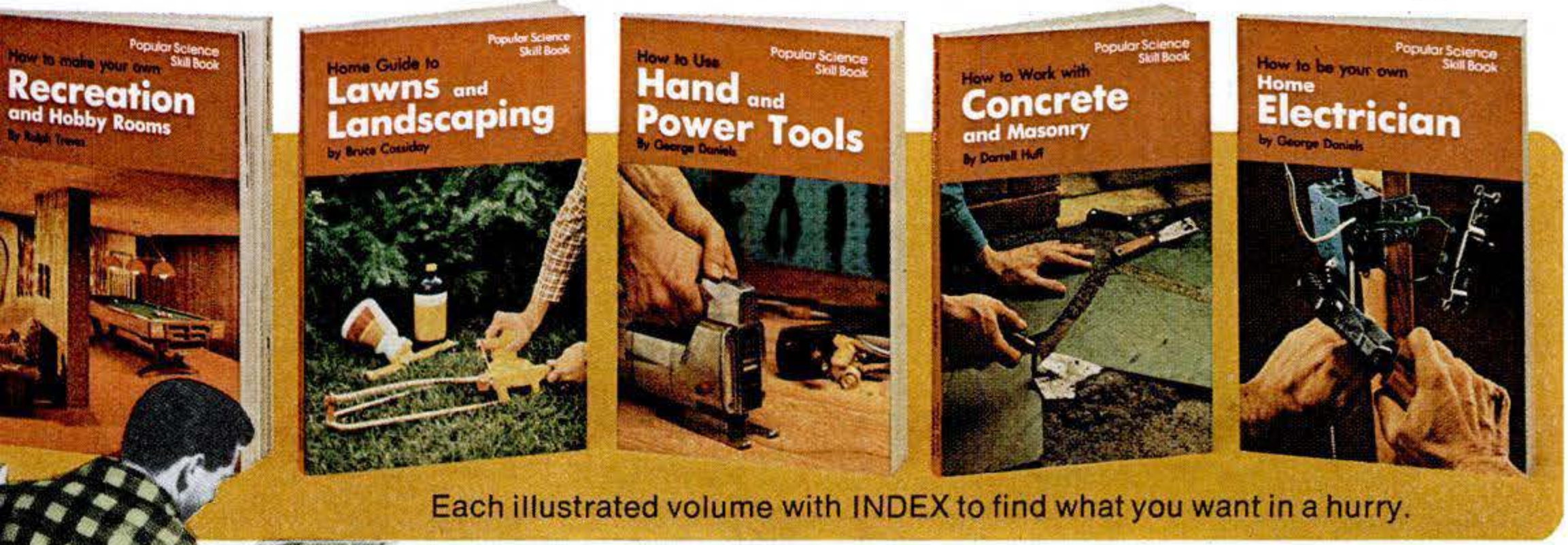

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Rear-seat passengers have little leg room in three cars tested. Interior of Cutlass shown here is typical—we measured its minimum knee room as zero.

Trunk room in all three cars isn't bad—14.7-15.9 cu. ft. Thunderbird trunk, above, has Space-Saver spare tire. You inflate it with an enclosed gas canister.

cars puts style ahead of function; wide C posts, low rooflines and long hoods combine to cut down on driver vision.

Let's take a look at each car.

Thunderbird

The new model has many vestiges of the big Birds of past years, including a long hood and short deck, excellent performance, and poor fuel economy. But the feel of a big, overblown, heavy car is gone. Handling and maneuverability have been noticeably improved. There has been some deterioration in ride comfort, but that is to be expected when you cut the wheelbase and overall weight. Still there is nothing shabby about the ride. It's just right for a model in the lower-priced personal-luxury market.

With its new styling, new lower price, and functional improvements, the Thunderbird is an appealing package this year. It is better matched to the high-volume competition and should be a successful model for Ford in coming years. The cutbacks the company has made in some luxury items such as interior trim, ride, and noise control are not serious, and do little to detract from the car's overall appeal.

Monte Carlo

For at least one month last year, the Monte Carlo was the top-selling model in the U.S. market. Its styling appeal is obvious. Just as obvious, after a few trips around town, is the ease of driving built into this chassis. It offers a highly responsive power train, a high level of ride comfort, and good maneuverability. Handling tends to be slightly more sedate than we like, but that's a secondary feature in a car of this type.

Match specifications of this car against the new Caprice and you'll see why Chevrolet plans to make big changes next year. The Monte Carlo is 300 pounds heavier and an inch longer, while having the same wheelbase as the full-size sedan. The sporty dimensions you expect to find in the Monte Carlo—in comparison with full-size sedans—are just not there. It will take a major downsizing to put Monte Carlo back in the sporty category. That's just what Chevrolet plans for 1978.

Cutlass Supreme

Exactly why is Cutlass the number-one seller in the U.S.? It's hard to say. There are other models, particularly the Buick Century Regal, that duplicate its features—but not its popularity. The specific sheet-metal styling does set Cutlass apart from other GM cars, and the waterfall grille is unique among intermediate-size cars. But there is more to it than that. Oldsmobile has a history of offering quality automobiles with the Cutlass label. Add to that the trend toward smaller models—a move that benefits Cutlass-type cars most, since they are the first step down from the big-car size—and you have a potent combination.

More than 80 percent of Cutlasses sold are coupes. The remainder are four-door sedans and station wagons. Those results seem to show that styling plays a big part in the overwhelming popularity of the two-door.

Like the Monte Carlo, the 1977 Cutlass is the last of its kind. Next year it will be smaller. PS

For test and spec results, turn page

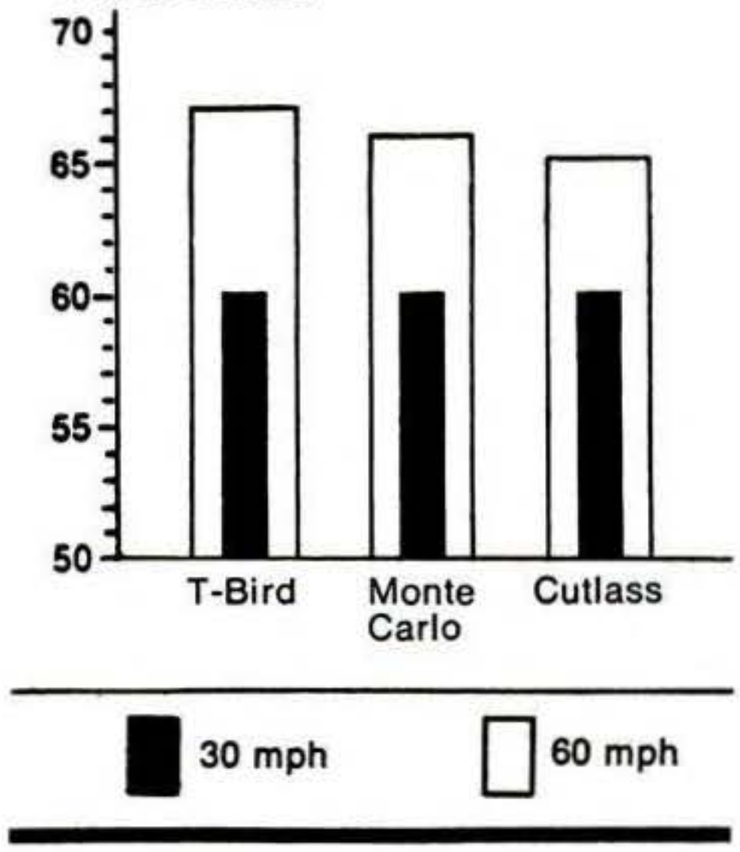
Serviceability ratings

How easy is it to service our test cars? For example, is that heater-hose clamp out in the open where it can be reached easily? To give you an approximation of how difficult it is for a typical person to perform various service operations on the cars, we examine each vehicle. Here's what the numbers mean: 1, very difficult; 2, difficult; 3, average degree of difficulty, no worse or better than most other cars; 4, easy; 5, very easy.

	Thunderbird	Monte Carlo	Cutlass
Checking fluid levels:			
Battery	5	5	5
Master cylinder	4	4	4
Windshield washer	5	5	5
Engine oil	5	4	3
Coolant	5	5	5
Checking engine:			
Spark plugs	3	2	2
Distributor	5	3	3
Carb adjustment	3	3	3
Oil filter	3	4	3
Oil fill	4	2	5
Replacing hoses:			
Top radiator hose	5	5	5
Lower radiator hose	5	4	5
Heater hoses	4	4	4
Changing bulbs:			
Headlights	5	5	5
Taillights	5	5	5
Front running lights	5	5	5
Front parking lights	5	5	5
Front directionals	5	5	5
Rear directionals	5	5	5
Rear running lights	5	5	5
Checking fuses	3	2	4
Spare-tire accessibility	5	5	5
Changing belts	4	4	5

NOISE-LEVEL TESTS

Interior noise is measured in decibels on the A scale on our standard General Radio sound-level meter applied under three sets of conditions. A reading of 50-dBA is like an average residence. A 60-dBA reading is like a large store; 70-dBA, like a freight train going by 100 feet away; 80-dBA, like a pneumatic drill at 50 feet.



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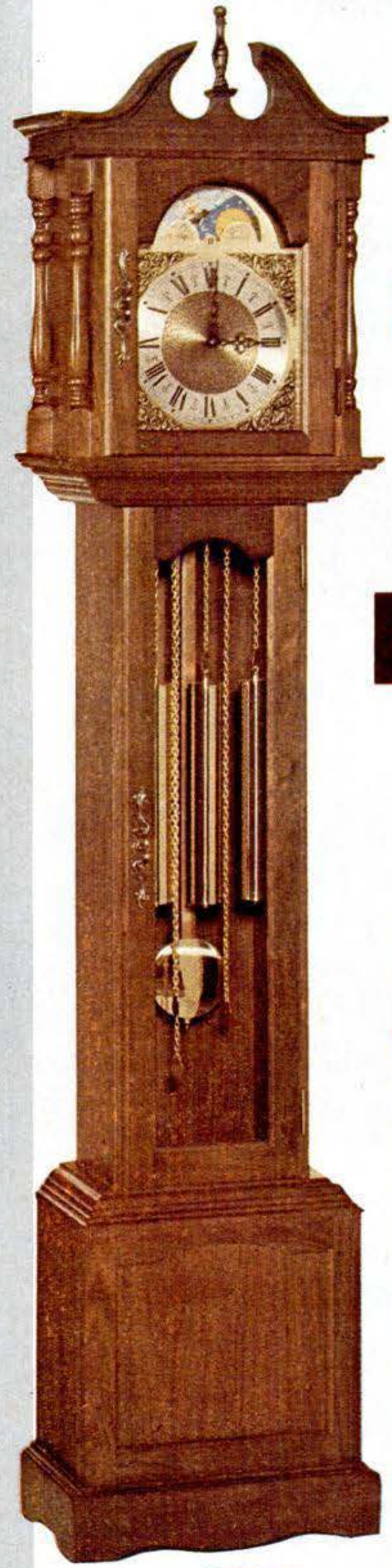

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EMPEROR MOVEMENTS AND DIALS FOR MODEL 120-K

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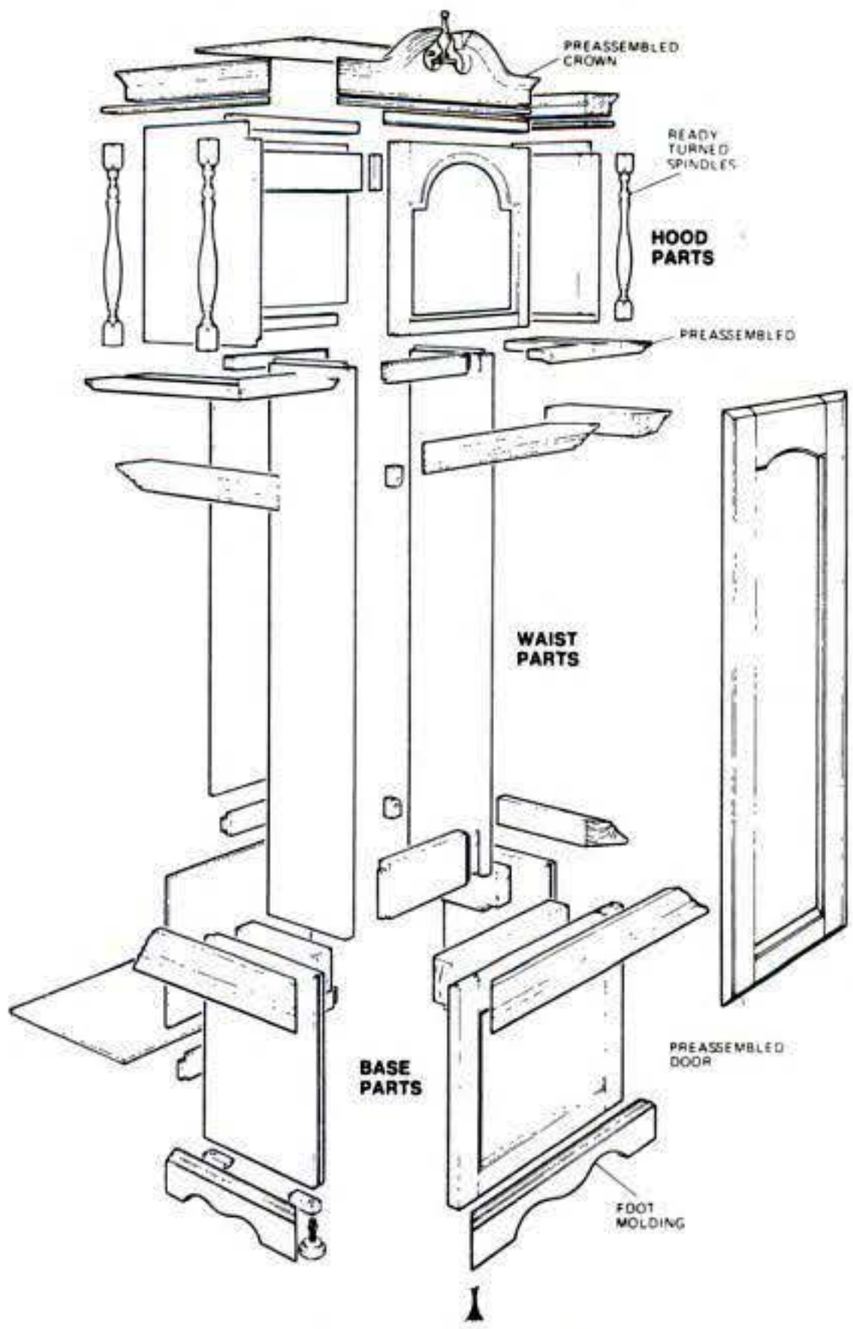

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Emperor Model 100-M movements, manufactured by a fourth generation of West German clocksmiths, are made to our rigid specifications from the highest quality solid brass, with pinions of hardened steel. Fully assembled movements include weights, solid brass weight shells, brass bob, pendulum and chimes.

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Emperor dials are also manufactured in West Germany by a renowned dial-making firm, famous for their solid brass craftsmanship. There are two dial versions of the 100-M movement: Tempus Fugit (Time Flies) and Moving Moon with classic lunar calendar. Both are solid brass and brush-finished with black serpentine hands. Antiqued filigree spandrels frame the dial ring which has black Roman numerals.

Because each movement bears the Emperor name, it is thoroughly tested in our quality control room before it is shipped to you. We proudly stand behind our name 100%. Emperor West German movements and dials are known and valued everywhere for their lasting accuracy and dependability. Don't risk buying anything less.

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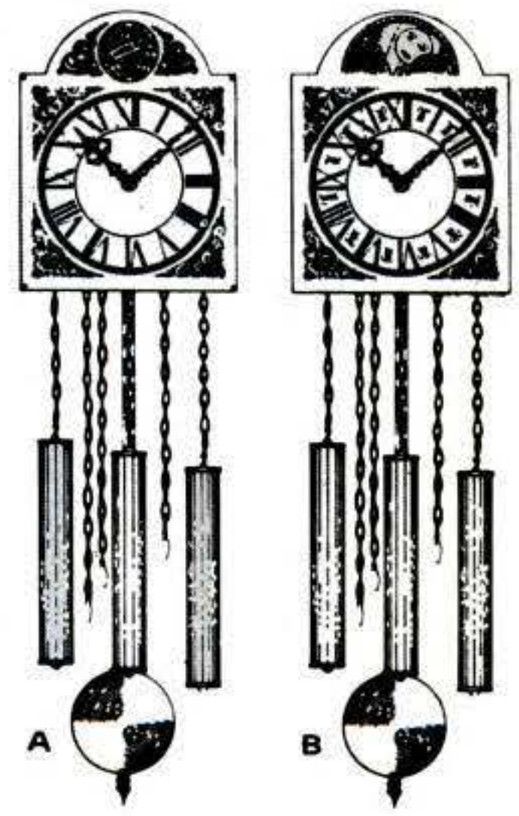

A. 100-M Movement with Tempus Fugit Dial $114.50

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	Model 120-K Solid ¾" Black Walnut Do-It -Yourself Case Kit with purchase of either movement (priced separately) below	49	$149.50	**$104.50**	
	Model 120-K Solid ¾" Black Walnut Do-It-Yourself Case Kit without purchase of movement (priced separately) below	49	$149.50	**$114.50**	
	Model 120-A Solid ¾" Black Walnut completely finished clock with Tempus Fugit Dial, Westminster Chimes	95	$399.50		
	Model 120-A Solid ¾" Black Walnut completely finished clock with Moving Moon Dial, Westminster Chimes	95	$414.50		
	Model 100-M Movement complete with Tempus Fugit Dial, Westminster Chimes for Model 120-K	33	$114.50		
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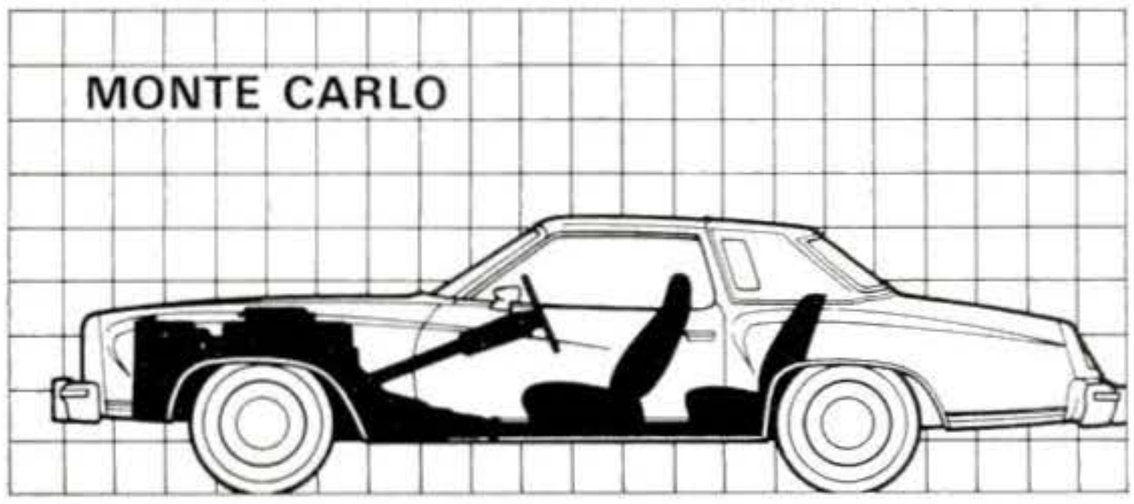

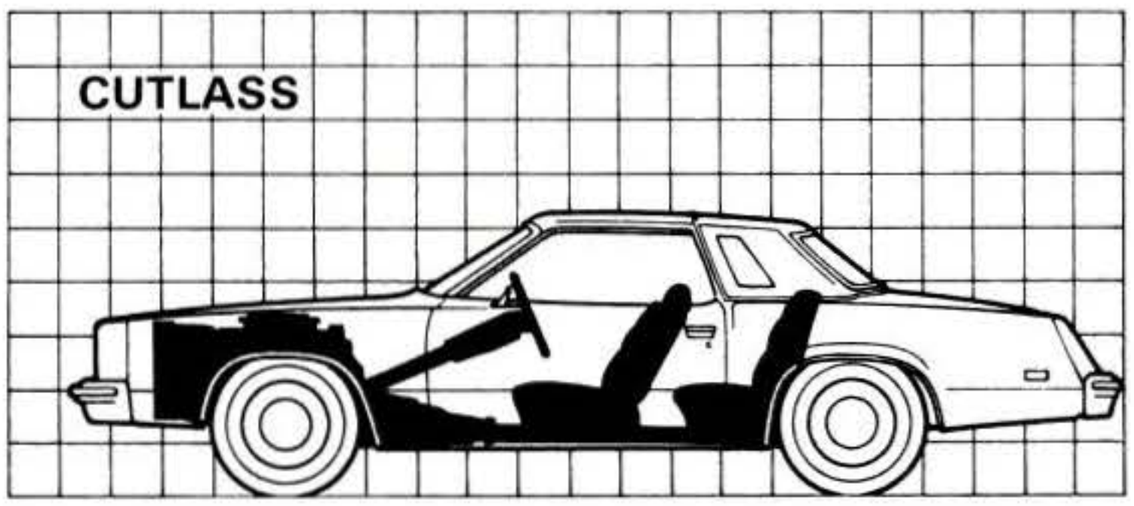

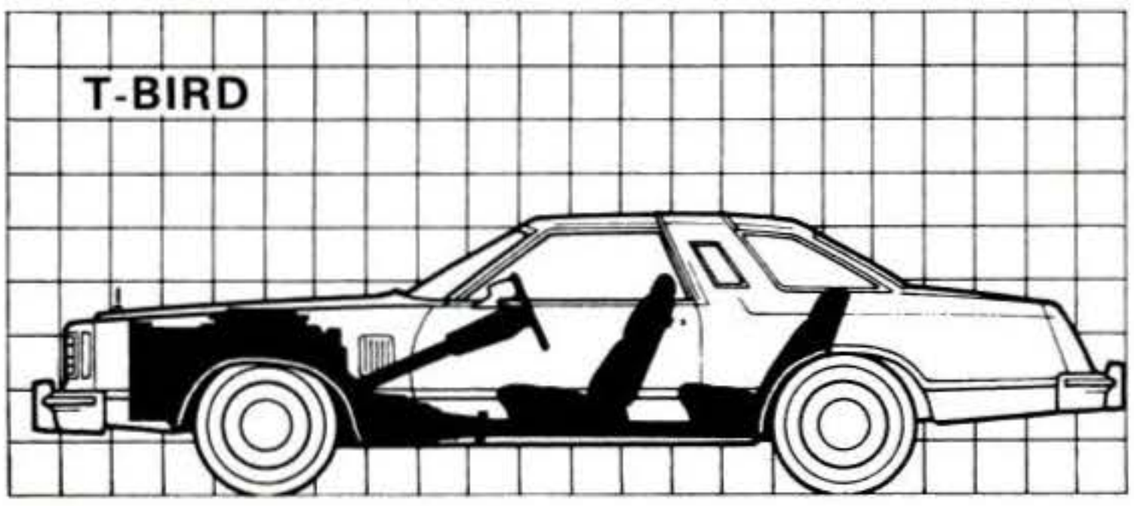

Dimensions of the three cars are nearly the same in many instances. Two biggest differences are the wheelbase and overall length. Monte Carlo checks in with the longest wheelbase, at 116 inches. That's four inches more than the Cutlass. Thunderbird is the longest car, though, at 215.5 inches.

Performance comparison with selected 1976 and 1977 models

	Mpg (city driving)	Accel. 0-60 mph (sec.)	Brakes 60-0 mph (ft.)	Handling (mph)	Maneuver (mph)	Noise @ 60 mph (dBA)
1977 Chevrolet Caprice V8	15	13.5	142	60.0	28.6	63
1977 Ford LTD Landau V8	11	13.9	168	51.3	22.4	64
1977 Plymouth Gran Fury V8	12	15.2	143	49.9	24.6	65
1976 Ford Torino V8	11	12.2	153	49.0	25.0	65
1976 Chevrolet Chevelle	12	13.5	170	53.0	26.4	66
1976 Dodge Coronet	14	14.0	120	56.0	26.0	66
AMC Matador V8	12	11.6	163	53.0	23.9	67
1976 Buick Skylark V6	18	16.6	138	60.0	26.0	68
1976 Ford Granada L6	12	22.7	135	58.2	26.8	65
1976 Dodge Aspen L6	17	19.5	159	58.2	27.6	66

Thunderbird, Monte Carlo, and Cutlass—specs, dimensions, and test results

	FORD Thunderbird	CHEVROLET Monte Carlo	OLDSMOBILE Cutlass
DIMENSIONS (inches)			
Ground clearance	6.9	6.8	6.4
Front leg room (max.)	42.2	42.4	42.3
Front head room	37.3	37.0	38.5
Rear head room	36.2	37.1	39.2
Rear leg room (min.)	32.7	32.9	33.3
Front hip room	55.6	54.8	54.7
Rear hip room	57.0	52.7	55.1
Couple distance	30.6	31.0	33.1
Min. rear knee room	1.2	1.3	0.0
Wheelbase	114.0	116.0	112.0
Overall height	53.0	52.8	53.4
Overall width	78.5	77.6	76.2
Overall length	215.5	213.3	209.6
Front track	63.2	61.9	61.1
Rear track	63.1	60.7	60.7
SPECIFICATIONS			
Engine type	OHV-V8	OHV-V8	OHV-V8
Displacement (cu. in./cc)	351/5750	350/5750	350/5750
Compression ratio	8.0:1	8.5:1	8.0:1
Carburetor	2 bbl.	4 bbl.	4 bbl.
Net hp @ rpm	161 @ 3600	170 @ 3800	170 @ 3800
Net torque @ rpm	285 @ 1800	270 @ 2400	275 @ 2000
Transmission	3-speed automatic	3-speed automatic	3-speed automatic
Axle ratio	2.50:1	2.56:1	2.41:1
Tire make	General	Uniroyal	Firestone
Tire type	Dual Steel II	Steel-belted radial	Steel-belted radial
Tire size	HR78x15	GR70x15	GR78x15
Steering	Power recirculating ball	Power recirculating ball	Power recirculating ball
Overall steering ratio	21.9:1	Variable: 16.5:1-14.3:1	Variable: 18.8:1-16.2:1
Turns, lock to lock	4.0	3.0	3.1
Turn diameter (ft.)	45.1	38.9	38.3
Front suspension	Independent—single lower arm, ball joint, coil springs	Independent—single lower arm w/coil springs	Independent—single lower arm w/coil springs
Rear suspension	4-link "stabul" suspension; coil springs	Linked; Salisbury axle fixed by control arms; coil springs	Linked; Salisbury axle fixed by control arms; coil springs
Front stabilizer-bar diameter (in.)	0.85	1.00	0.88
Rear stabilizer-bar diameter (in.)	0.75	1.00	0.812
Brakes	Power-assisted disk/drum	Power-assisted disk/drum	Power-assisted disk/drum
Brake swept area (sq. in.)	369.0	348.6	363.0
Fuel tank (gal.)	26.0	22.0	22.0
Trunk space (cu. ft.)	15.4*	14.7	15.9
Liftover height (in.)	28.0	26.0	26.0
Curb weight (lb.)	4412	4143	4221
F/R weight distribution (%)	56/44	54/46	55/45
Trailer-towing capacity (lb.)			
Tongue weight	700	750	400
Gross weight	6000	6000	4000
Basic price	$5063	$5297	$4968
Price as tested	$7545	$7437	$7161
TEST RESULTS			
Acceleration 0-60 mph (sec.)	15.1	11.5	12.3
Acceleration 0-80 mph (sec.)	27.3	20.0	19.9
Acceleration 25-70 mph (sec.)	16.2	13.1	12.5
Brake test (cool) 60-0 mph:			
Stopping distance (ft.)	120	149	149
Pedal pressure (lb.)	80	80	140
Efficiency (% of 1 g)	100++	100++	100
Disk temperature (°F)	205	125	115
Brake test (hot) (60-0 mph)			
Stopping distance (ft.)	163	192	180
Pedal pressure (lb.)	200+	200+	190
Efficiency (% of 1 g)	100	85	95
Disk temperature (°F)	400	510	525
Handling test (mph)	54.5	58.2	60.0
Maneuverability (mph)	25.0	26.0	25.0
Interior noise @ 60 mph (dBA)	67	66	65

TEST CONDITIONS: Ambient temperature, 48°; relative humidity, 50 percent; barometric pressure, 30 inches

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Plagued by coolant loss

I have a 1970 Buick and a 1973 Chevy Step-Van, both of which have an overflow reservoir for coolant. And I'm constantly adding antifreeze in 50-50 proportions. Yet I have a 1965 Chevy with no reservoir, which never needs added coolant. What's wrong?

R. E. Beaudoin, Brookfield, Ill.

Coolant will vaporize when heated; if allowed atmospheric venting, there'll be a small, continual loss. A sealed system that can handle expansion of the coolant without atmospheric venting would in theory not lose any coolant.

So if you use a pressure cap that's not above the structural limits of your cooling system and add an expansion tank that would be plumbed so that the de-aerated, expanded coolant would again be presented to the water-pump intake, you would have a minimal loss of fluid.

The expansion tank can't be vented to the atmosphere, though, and for safety would have to have an emergency pressure relief. Some cars have this—Corvette, for example.

Hesitation

I have a 1973 Gremlin with a 223-cu.-in. engine and solid-state ignition. My problem is that when the engine is cold, it will backfire through the carburetor. When the engine is warm, it hesitates during acceleration. The carburetor has been replaced along with normal tune-ups.

Earl Tanguay, Neenah, Wis.

Backfire through the carb is caused by a lean fuel condition or by an open intake valve. Nine times out of 10 it's too lean, and that's caused by a weak accelerator-pump shot. Late timing will also cause hesitation during acceleration.

Your carb still needs work. Find a good carb man. The cause is probably inside, and nobody's going to fix it walking around it with a screwdriver.

Should you change oil?

In the first 40 years that I drove cars I was told, "Change your oil regularly, because it gets dirty and diluted. But it never wears out." Now in the past 10 to 15 years I have been told it is the additives that wear out.

I just purchased a 1972 Electra with a 455 engine, and to my surprise it had a special filter on it. The company that installed it advises me that I never need to change oil—just add oil when needed, but use a good grade of 10-30 or 10-40 oil.

The oil *is* very clean. But how can I tell if it has the proper percentage of additives? And, when I add a quart of new oil about every 1000 to 2000 miles, will that add enough additives?

Frank Ziegler, Cincinnati, Ohio

Frank, nobody wants to waste oil or money. But oil never wears out? Baloney. Oil is not just one simple chemical that never changes regardless of temperature cycles, dilution by chemical additions or subtractions, or vaporization.

Lifetime oil filters? More baloney. About half an inch of oil lies beneath your oil-pump pickup. Also, anything that has a higher specific gravity than oil lies there, and much of it recirculates by splash, turbulence, and pressure changes in the pan.

So let's get back to the real truth. Some filter systems are better than others. The oil needs changing in all cars, and oil could and should be recycled.

Exhaust odor

I own a 1974 Mazda RX 3 station wagon with the rotary engine. When I open the back of the wagon, as when carrying long packages, the exhaust gas burns my eyes and throat. With the back door closed and the back windows open, the rear passengers complain of the same.

Robert A. Young, Whiting, Vt.

Your problem is simple. The solution won't be. The exhaust gases are being sucked into your car because air from the rear of the car is being circulated in the passenger compartment. This happens because the passenger compartment under the conditions you describe has a lower pressure than the final exhaust exit. A gas will flow in the path of least resistance. So if you are an engineer with air-flow credentials you may find a better exit, or add or subtract air foil and stop it. A non-engineer might try extending the pipe far enough behind. But that could mean three or four feet, and obviously that won't work. It's a design problem, and I'd guess the odor you get is sulfuric, from a hot exhaust control. Try a call or letter to the factory.

Thinks he spotted an error

Please reread your reply in the Sept. '76 issue regarding spark-plug wires.

A wire in a bundle has double insulation, its own and its neighbor's. A single wire is easier to troubleshoot, but not necessarily a better installation. Think you need a retraction?

J. J. Schiller, Anchorage, Alaska

Before I answer, try something for me: Take a new car with CD ignition, put the plug wires together in a bundle, and let me know how that works.

About spark plugs

During the last few years I have read about the so-called "center electrode" spark plugs. What about them?

J. P. Sheehan, Denver, Colo.

Ever since I was a kid—and that's some time ago—I've been looking at spark-plug inventions, and maybe even come up with an idea or two used in current plugs.

I've also been looking at and testing new plug ideas. So far, Champion-AC-Auto Lite have done the job as good or better than anything else I've seen. I'm not trying to say somebody else won't do it better. Actually, I think it's possible, and past time that it was done. The plugs you describe have been around for some time.

Spark plugs look so much alike that most people think they're all the same, and need no special care. Not so. The best plugs have developed through years of testing, so don't vary from manufacturer's recommendation.

Do headlights use gas?

Does the electrical load of headlights on the alternator make any difference in gasoline consumption?

R. Bye, Marlton, N.J.

Mileage will drop very slightly with headlights on. As a matter of fact, any and all electrical energy your car uses must be paid for in energy to run the alternator.

As the automobile evolves, I see the battery-alternator getting bigger and bigger as the electrical inventions pile on. And I wonder how long this can go on. Kind of like the fan: It got bigger and noisier, eating gas like crazy. Then collectively everybody did something.

Stalling and wheel shimmy

My 1976 Aspen with 318 V8 engine stalls when cold, though it behaves flawlessly when warmed up. The service manager at my Dodge dealer says that—for the sake of emission control—the heater element in the choke is

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t to open it too soon. But he seems able to do anything about it. Any ggestions?

Also, I get front-wheel shimmy at actly 45 miles per hour. They balced and rebalanced the front wheels thout effect. Can you figure that one?

Samuel Mines, Southbury, Conn.

ur choke is for fuel enrichment, hich is necessary when the engine's take manifold is cold and fuel doesn't porize enough to get good distribun. With a carb-manifold design you ust preheat the manifold or add fuel. choke retraction must be slowed wn, or idle and/or idle transfer el must be increased. Trouble here that's probably gonna knock it out emissions limits. So you can't come t legal.

The tire deal is the old story—you n balance a square block but it won't le well. True the tires or get round heels and round tires. Or try chemtry—liquid balance sometimes works.

eeds an overhaul

ave driven my 1969 Dart 225 93,000 iles. A recent compression check realed that all cylinders are within ecifications except number three, hich read 70 pounds. Since the car as new, I have religiously changed oil d filter every 3000 miles. The car es about one quart of oil between anges. My friend says that I need a lve job, and I agree. But he says at I should also have new rings, bearngs, and wrist pins.

Is he correct? Do I need a complete ngine overhaul?

eorge R. Steinreich, Sacramento, Calif.

agree with your friend. In my opinion 3,000 miles is a good life. You probly have a leaking valve; you could just that. But from a get-the-mostr-your-dollar viewpoint and from exerience, I'll tell you this: Either get e engine completely gone through nd parts replaced as necessary, or rget it. And make sure the person ho does the job is qualified. This is no b for an amateur.

roubled with gas odor

have a 1969 Ford LTD with the 302 ngine. During the last few months I ave been frequently getting a raw asoline odor inside. I have checked nder the hood and at the gas tank, ut cannot find any signs of leakage. I ave no problem with the performance f the car when it happens.

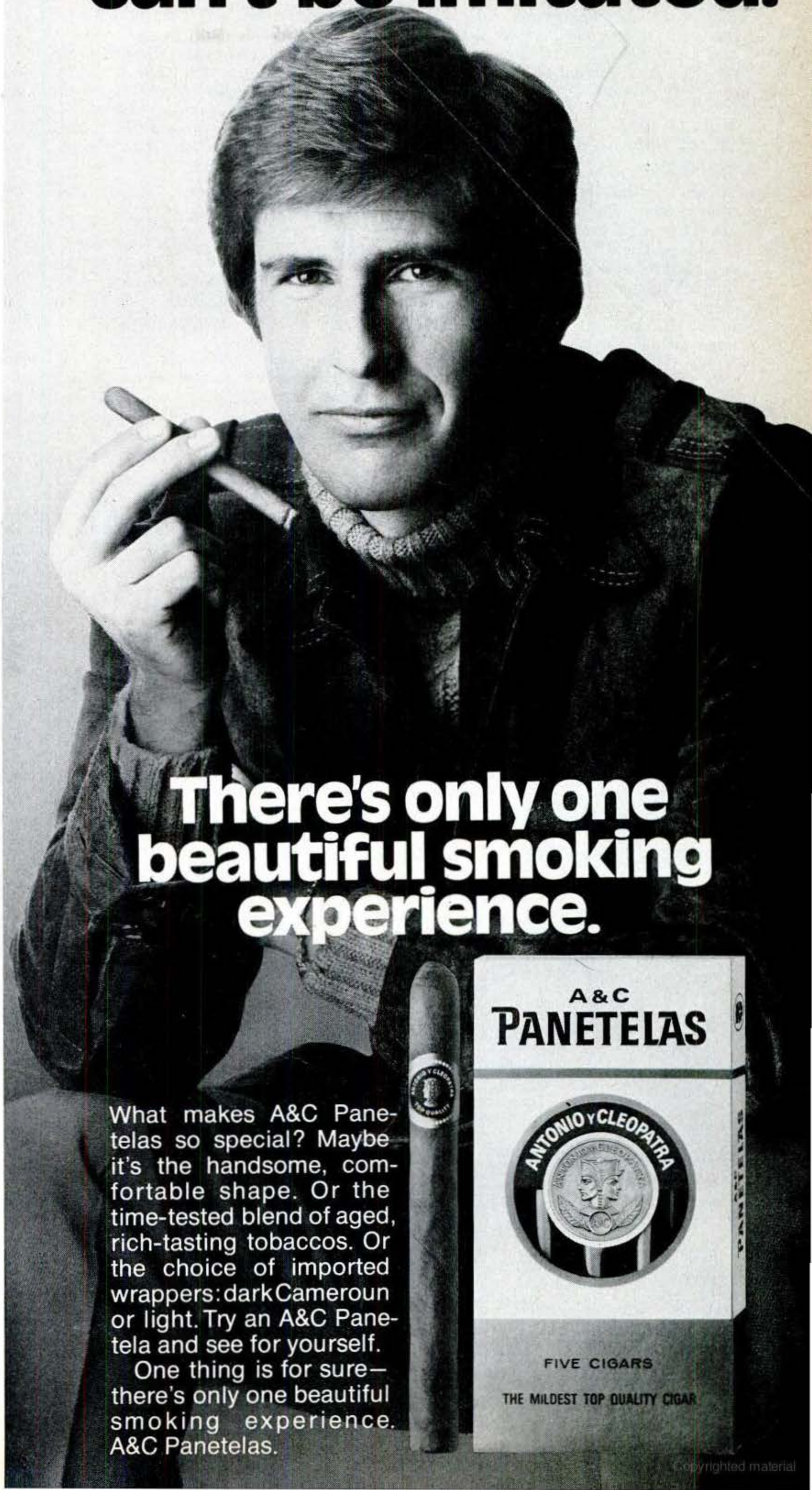
Leon Baton, Kenilworth, N.J.

iggest offender is fuel-tank overflow uring and after fueling. Another posible cause is a leak in one filter area r on top of the tank, and these fumes et in the passenger compartment hrough windows and vents.

Once in a great while, older model ars have metal fuel lines that rust and t fuel seep down the frame en route the fuel pump. Under-hood fume ossibilities are a fuel pump with a aking diaphragm that's dripping raw

Continued

A&C Panetelas can't be imitated.



What makes A&C Panetelas so special? Maybe it's the handsome, comfortable shape. Or the time-tested blend of aged, rich-tasting tobaccos. Or the choice of imported wrappers: dark Cameroun or light. Try an A&C Panetela and see for yourself.

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[*Continued*]

fuel, leaks on the pressure side of the pump lines, leaking filters, or carb trouble. Carb leakage is usually from fuel-bowl gaskets, or fuel flooding after the engine is shut off.

Occasional no-start

We have a 1971 Chevrolet Sportsvan 20 with a 350 engine and automatic transmission. For three years now we have had this problem: When the engine is hot and is switched off, it will not restart until it has cooled for an hour or longer. This occurs about once every 10 times. Several mechanics have worked on it—$600 worth to date—with no success. Any ideas?

Bro. Joachim, Bay Saint Louis, Miss.

What's probably happening is that high underhood temperatures are causing excessive fuel-pressure vaporization. A carburetor does a pretty good job of metering gasoline. But when gas is heated it changes so drastically (in its weight, state, volume, and pressure) at temperatures between 100° and 150° F that the carb loses practically all control and the book goes out the window. Have your mechanic take steps to cool the fueling system and your problem should disappear.

A host of problems

I own a 1971 Chevelle Malibu with a 350 V8 and two-barrel carburetor (90,000 miles on it). I've taken the car in to be fixed several times, with no improvement. Here are the symptoms:

1. Hesitation upon acceleration, especially in the lower speeds.
2. Engine often dies when hesitating, almost always in a quick stop, and sometimes when making a turn.
3. Very rough idle.
4. Excessive radio interference—crackling that gets faster as the car picks up speed.
5. Ticking sound, not too loud but noticeable, usually at speeds up to about 35 mph. It appears to be coming from the passenger side.
6. Occasionally when accelerating, the transmission seems to be holding back, wanting to return to a lower gear.

All these things started to happen the moment I drove out of Sears, where I had a new exhaust system installed in the middle of January. Since then I have had a complete tune-up. I changed all vacuum hoses (which helped a little), changed all the filters and the distributor cap, put on new spark-plug wires (radio noise started then), put on new fan belts and, at the suggestion of the mechanic who examined my car several times, had a new carburetor installed. The mechanic just about swore that it would cure all the difficulties, but it did not.

The car has been driven by mechanics, put on the scope and other test equipment, checked out by the Chevy dealer from whom I bought it, but no one seems to be able to find out what the problem is.

One of the automotive books that I consulted suggested removing the capacitor by the coil, which, if faulty, might cause misfiring at a low speed and radio interference, but I have not noticed any change for the better. I also checked the thermostat in the thermostatically controlled air cleaner.

The biggest mystery is that—except for the radio interference—all other problems are occasional, not constant. And this might be why nobody was able to find out what is actually wrong.

Samuel J. Karp, Okemos, Mich.

Start with a cylinder blowdown. Check it out on a Sun analyzer. If that comes up normal, 90 percent of your trouble is carb-distributor and the wrong kind of plug wires.

Hesitation, rough idle, and stalling result from a lean accelerator pump, incorrect fuel level, incorrect idle air-fuel ratio, and a too-lean mixture in transition from off idle to drive. Late ignition timing and incorrect plugs can also contribute to the above.

I believe you'll find the radio noise comes from the new plug wires, which have an all-metal core, instead of the special wires the car came with.

Check the heat-damper valve for correct operation, too. PS

Each month in *Popular Science* Smokey Yunick answers questions on cars—family cars, high-performance jobs, hot rods, and racing cars—selected from those sent in by readers. Got a problem? Send it to: "Say, Smokey—," Popular Science, 380 Madison Ave., New York 10017. Questions cannot be answered by mail.

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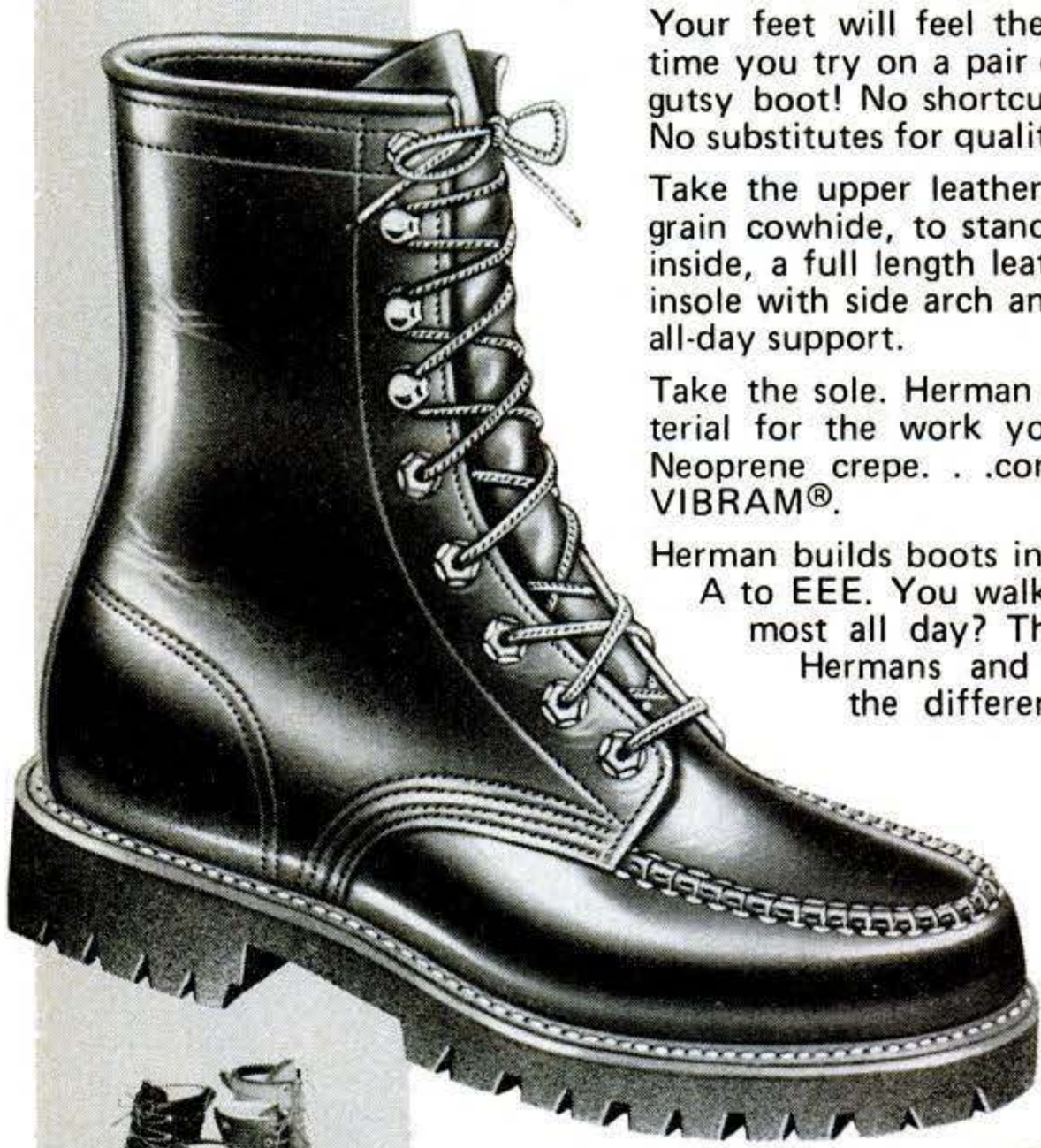

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David S. Cooper
Bloomfield Hills, Mich.

Mr. Cooper is a sportsman who takes long trips into hunting country. That's why he owns a Chevrolet Blazer and also why he insists on having Tilt-Wheel Steering.

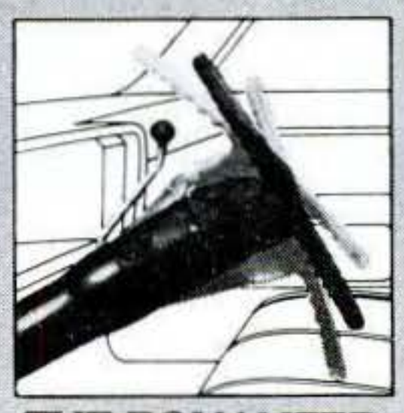
Mr. Cooper points out that Tilt-Wheel moves up out of the way to help make getting in and out easier.

He also told us he likes the way you can adjust the wheel to different positions—even while driving—to make long trips more relaxing.

Some GM cars offer Tilt & Telescope Steering. That means you can adjust the wheel in and out, as well as up and down, for even greater comfort and convenience.

Tilt-Wheel. Tilt & Telescope. They're the Equalizers. They adjust to every driver in the family—short, tall, slim or portly. All sizes.

Ask your General Motors dealer for a demonstration soon.



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Compact plug-in car fuse

Ever try to remove a fuse from your car's fuse block? You're on your back, upside down, wielding a screwdriver and hoping to pry the glass tube high enough from its prongs to grab it with your fingers—only to have it snap back in place or break.

If you buy one of the '77 GM big cars, you won't have to struggle like that any more. The cars have Autofuse—basically a plug with a fuse built into one end—which can easily be removed or installed. The fuse is in a clear plastic fusebox that lets you see the element and spot a blown fuse with just a glance at the panel.

Its rating is easier to read, too: It comes in six sizes (3, 5, 7½, 10, 20, and 25 amperes) with ratings stamped in large easy-to-read numbers on the edge of the fuse. Auto designers appreciate the Autofuse as well; it takes up less space than a conventional fuse-block system. Cost should be about comparable with standard fuses.

They're made by Littelfuse, a subsidiary of Tracor, Inc., 800 E. Northeast Hwy., Des Plaines, Ill. 60016.—*W. J. Hawkins*

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Marine CB

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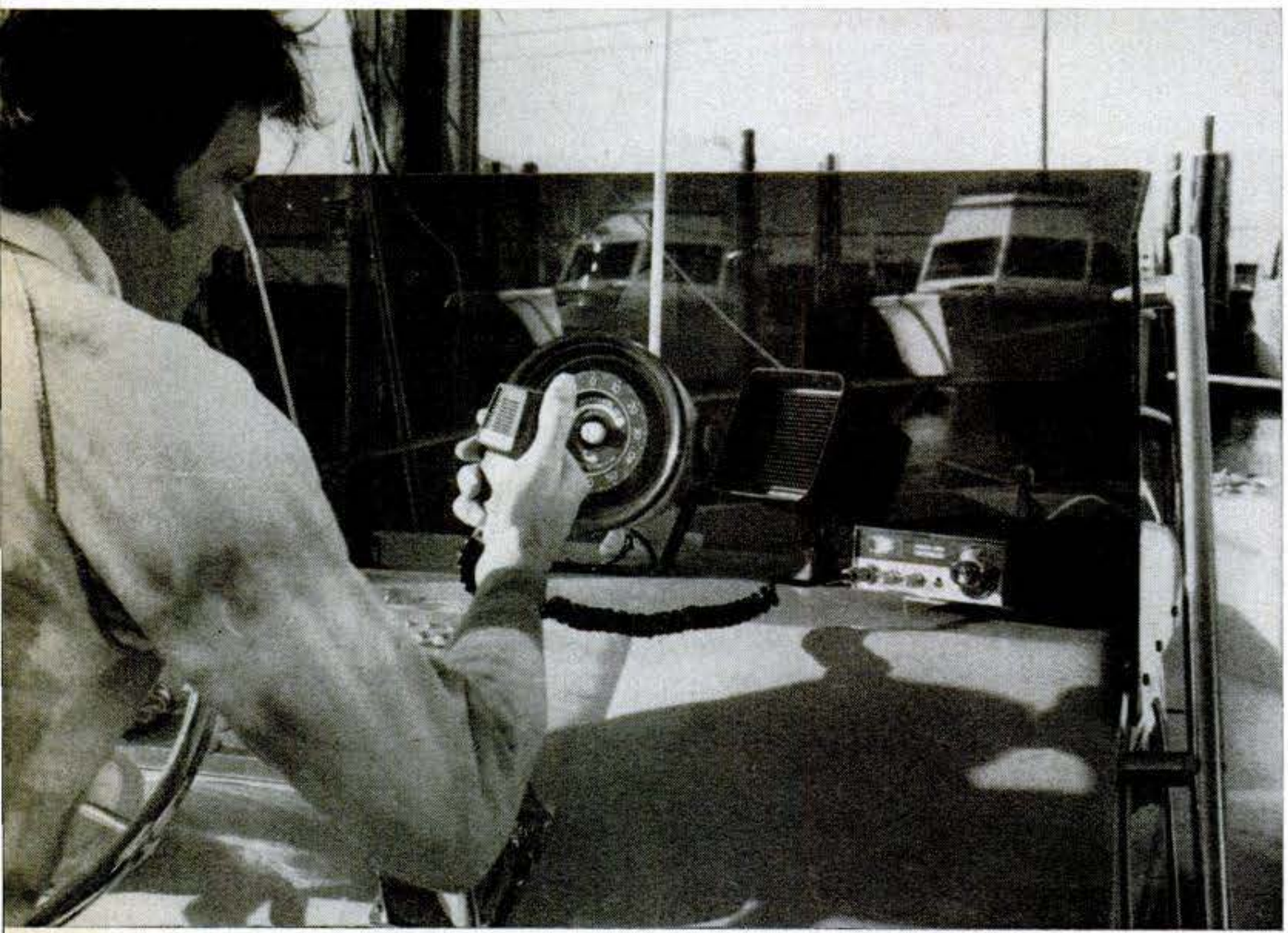

Start "gearing up" for communications on the water this summer

By WILLIAM J. HAWKINS

Mount a CB radio on your boat and you've probably just installed one of the best pieces of safety gear since the compass. Sure, you'll know when and where the fish are running, when to head in from a storm, or where to get a tank of gas. But you'll also know there's someone there—at the other end of the mike cable—willing to help in case of an emergency.

A marine CB is probably easier

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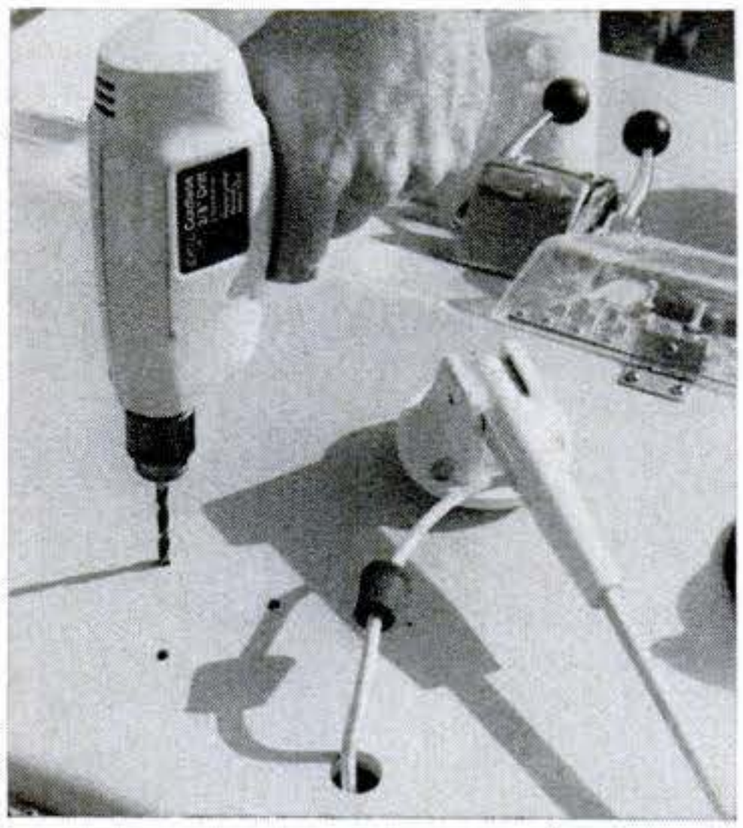
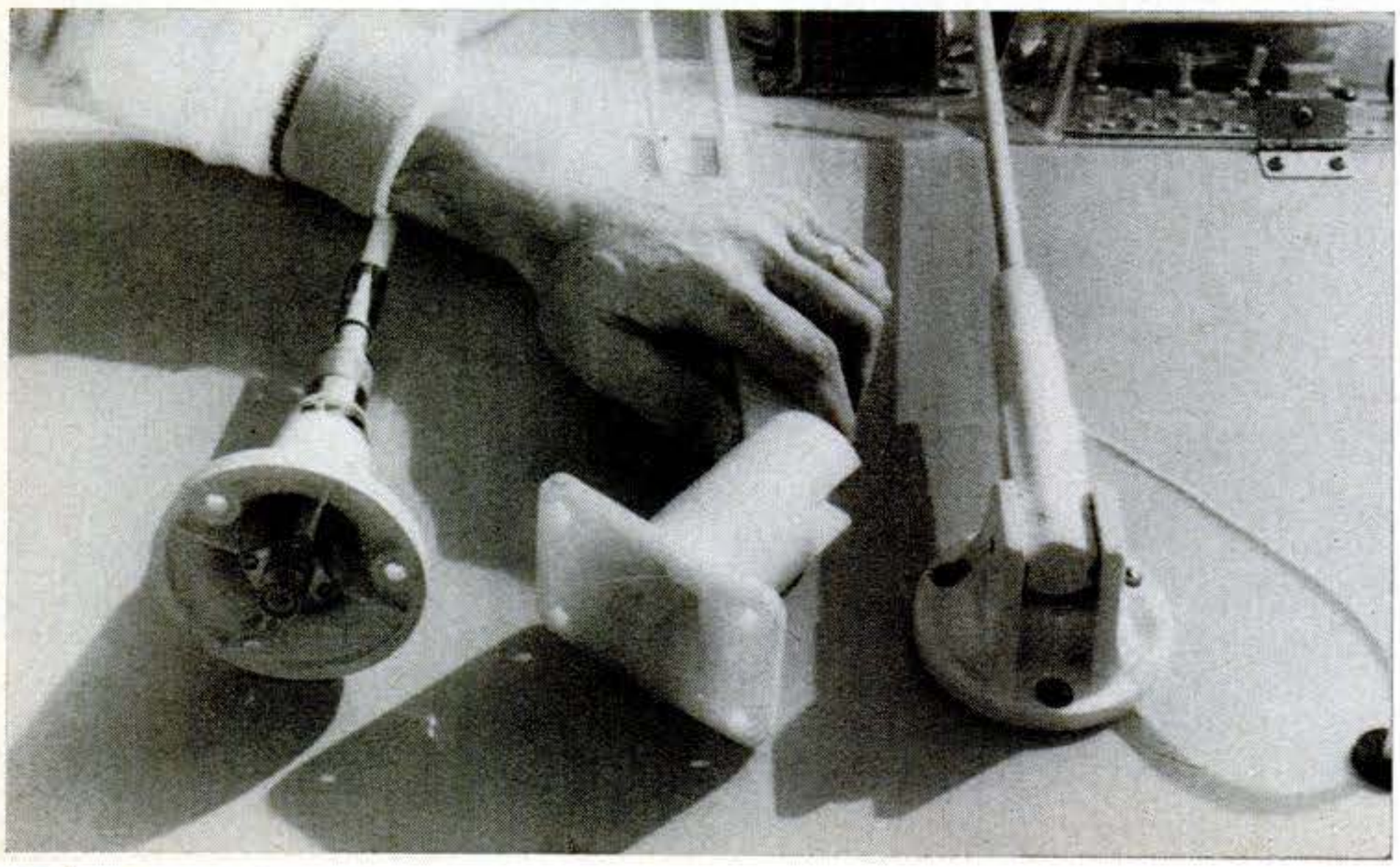


Drill holes for antenna, mounting base, and cable. Oversize cable hole accommodates rubber feed-through cork (supplied with antenna) to keep out water.



Marine mounts vary from enclosed connector type (left) from Antenna Specialists, rectangular base from Pearce-Simpson, to round Shakespeare model.

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[*Continued*]

to install than a mobile CB for your car. Many mounting surfaces are available, and the wiring is accessible. The system will be exposed to salt air and water, however, so there are a few differences to consider.

As shown in the photos, all holes for screws and wiring should be made watertight and corrosion-resistant. A silicone sealer, often supplied with the antenna, works well for this. (Use only a specified "marine antenna"—it's physically and electrically designed for boat use.)

Naturally, the rig should be protected from the elements as much as possible. The windshield will usually be sufficient for rigs mounted on the instrument panel as shown.

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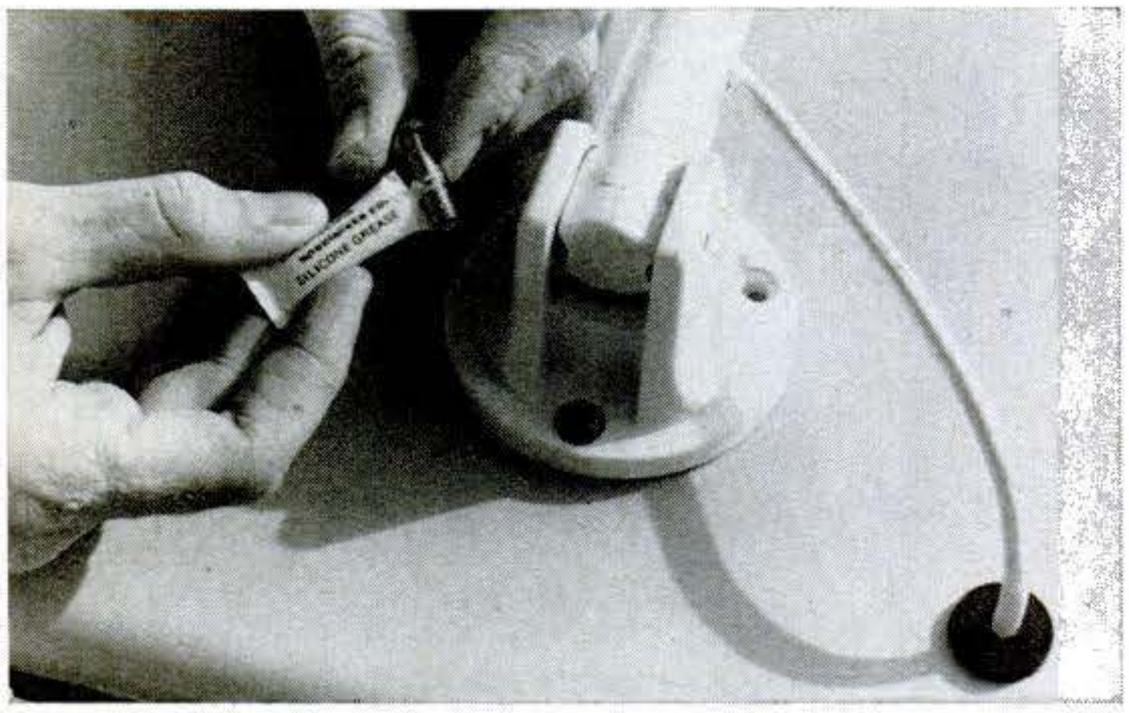
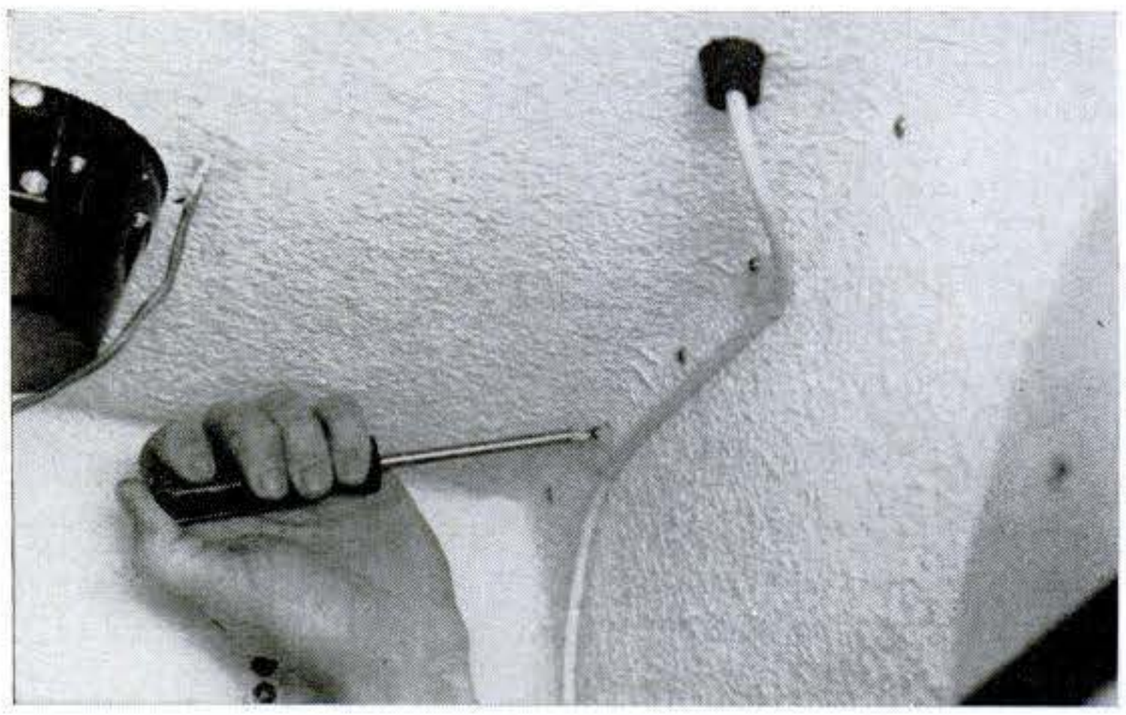
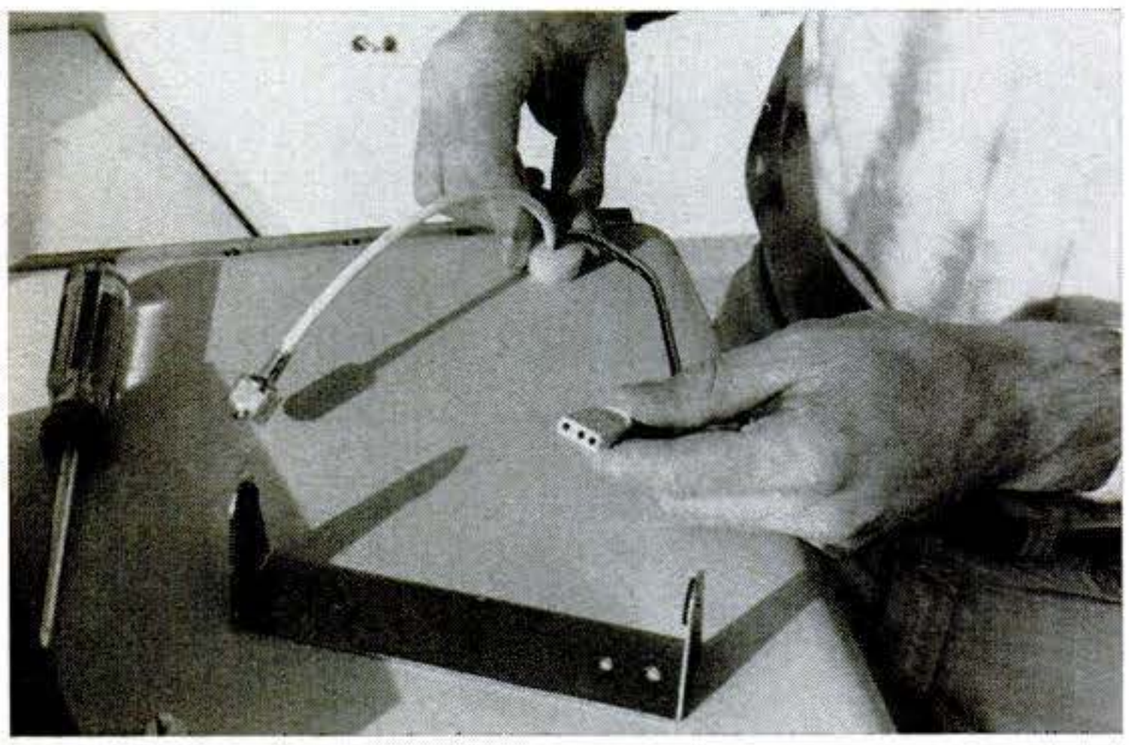


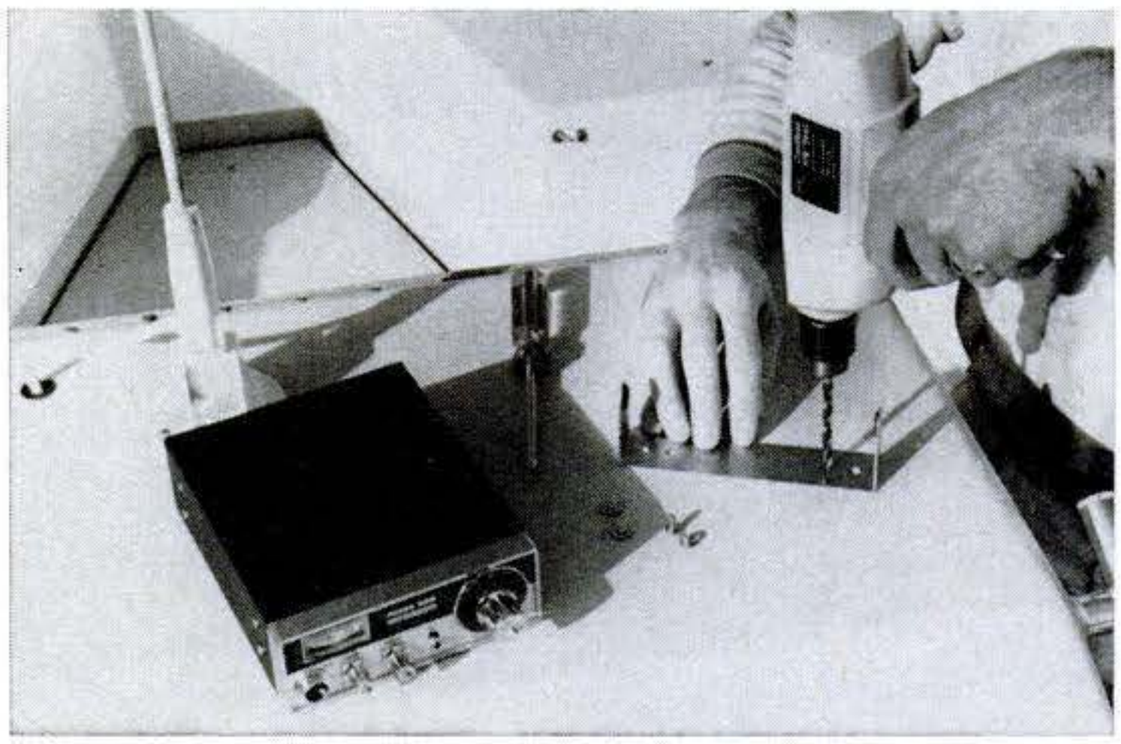
Apply a water sealant to all screws before insertion. (Silicone grease is used here.) This prevents leakage into bulkhead and corrosion of screws. Lead-in cork should be snug.



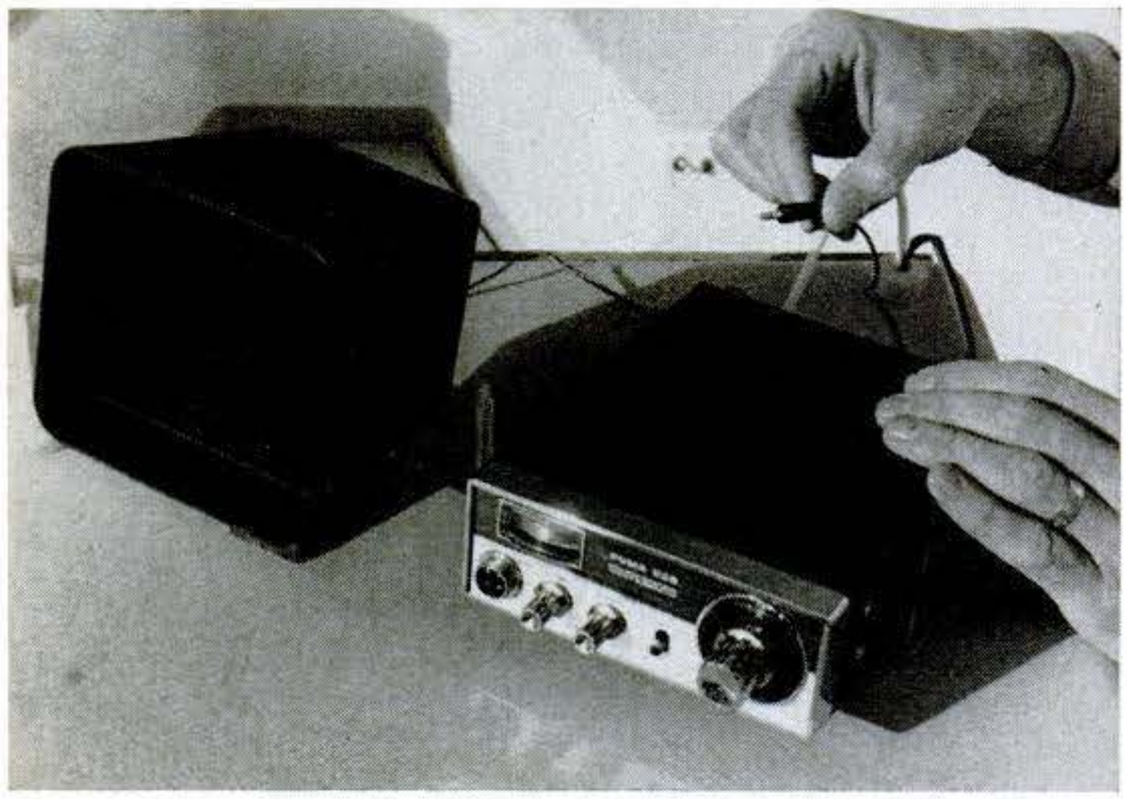
Plastic cable clamps hold coaxial antenna cable up and out of the way on inside bulkhead. Clamps should be snug against cable, but not pinching. Use a clamp at foot intervals.



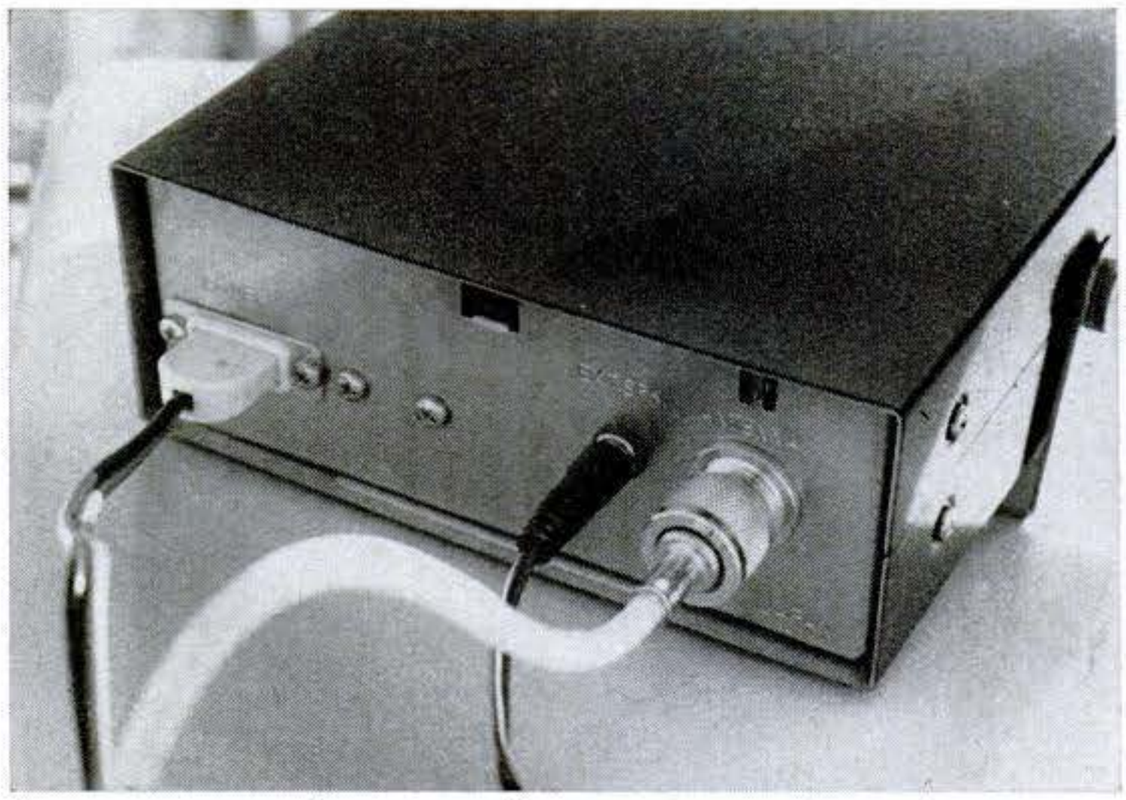
At CB mounting location, drill another hole large enough to pass antenna connector and battery wires. Use another rubber grommet (split to insert wires) to keep hole watertight.



Drill holes for mounting bracket in instrument panel. Use a nut and bolt (with sealant) to secure. Angle bracket so the set is easily visible from behind the wheel.



External speaker, like this one from Acoustic Fiber Sound, is essential for hearing the CB above motor noise. Rigs like this Pearce-Simpson have external speaker jacks on rear.



Connect power input, antenna, and external speaker to connectors on rear of rig. If CB has polarity selector switch for battery connections, throw it to negative ground position.

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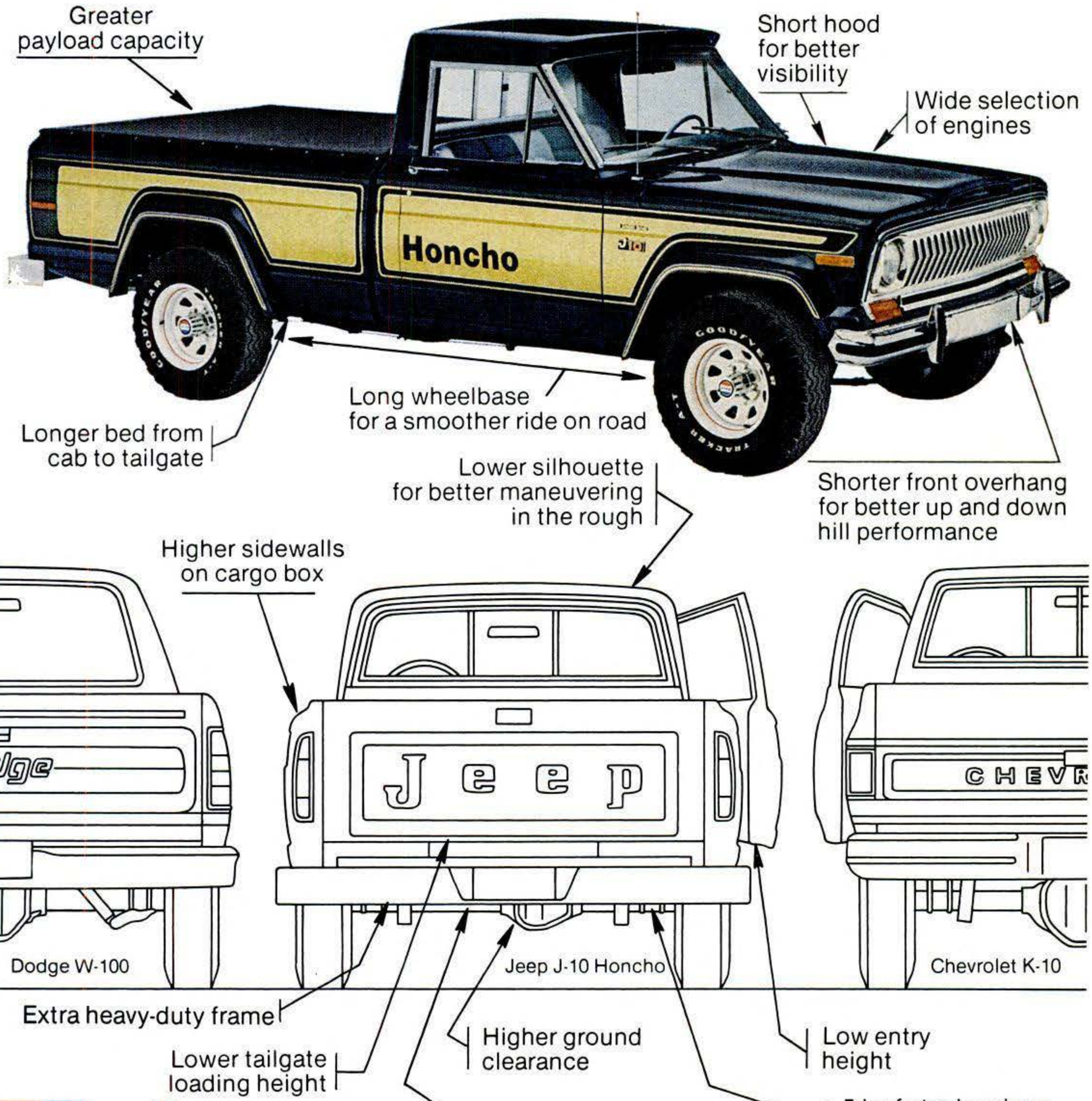
Jeep® Pickup puts down the facts... (and the competition)



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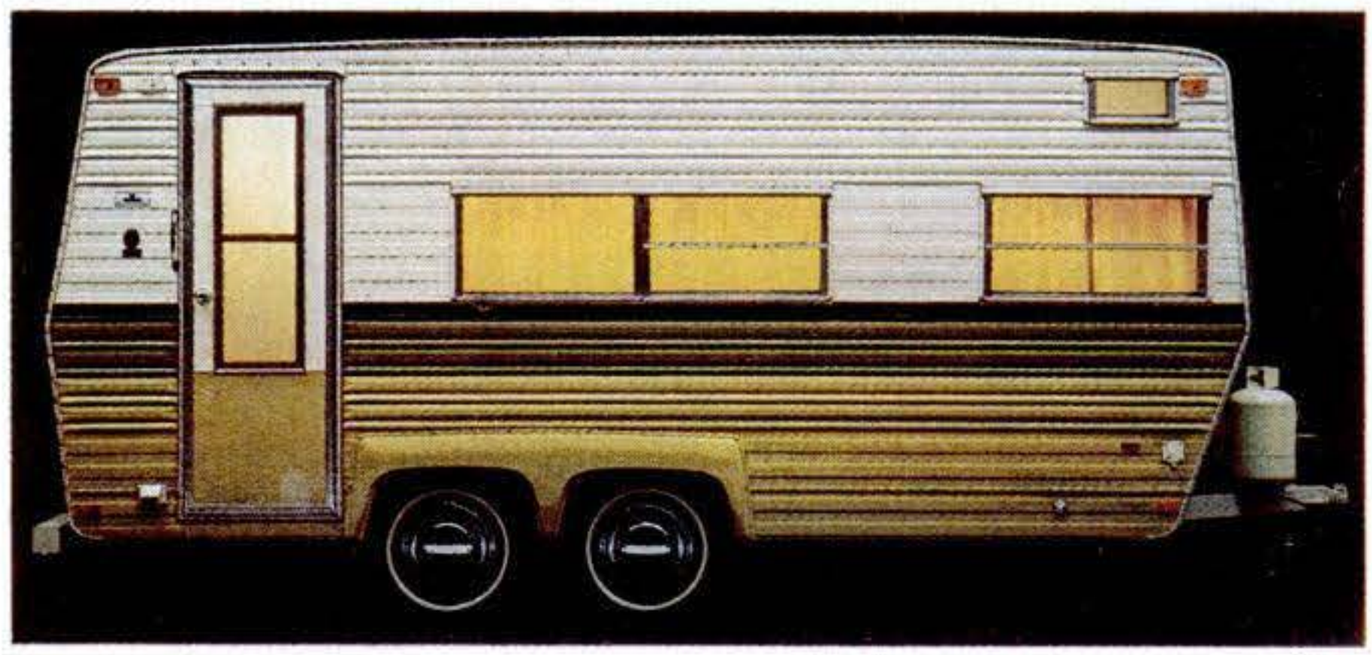

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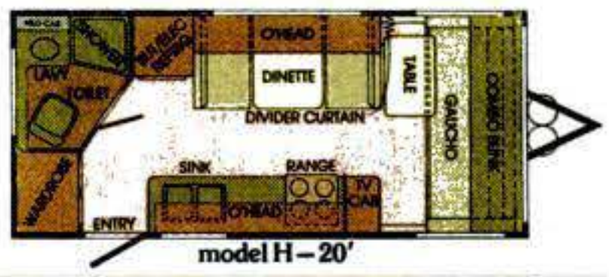
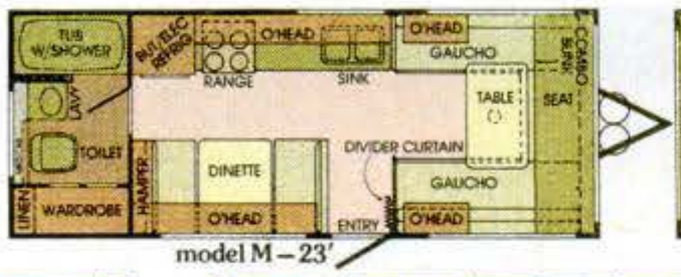
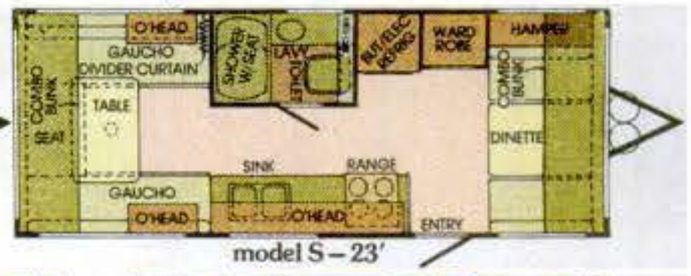


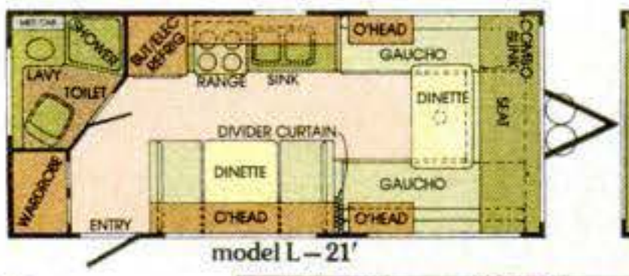
model H – 20'



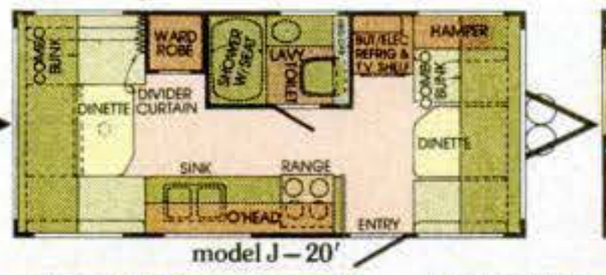
model M – 23'



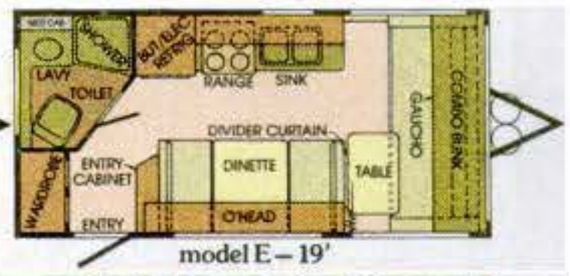
model S – 23'



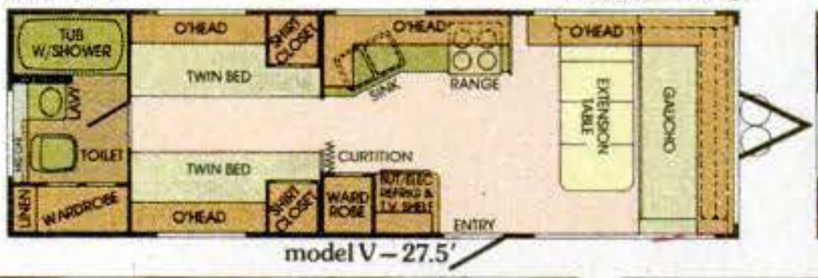
model L – 21'



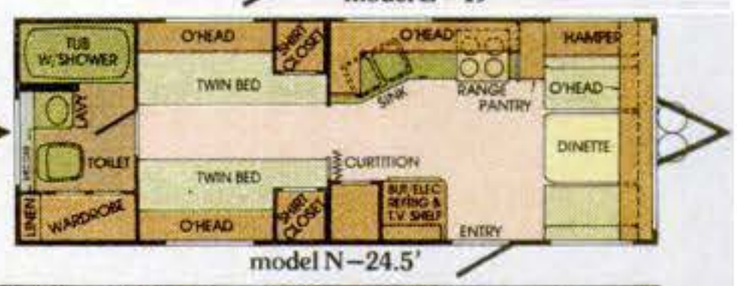
model J – 20'



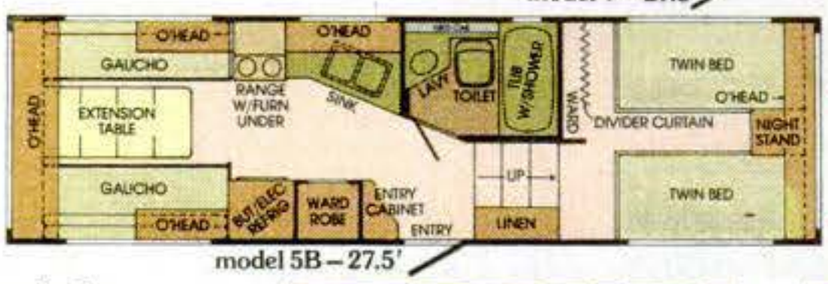
model E – 19'



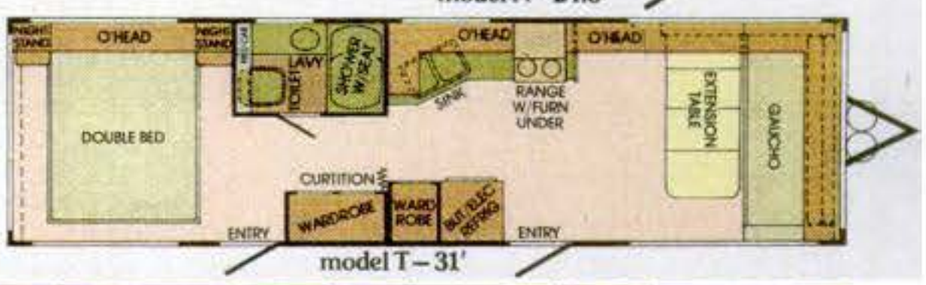
model V – 27.5'



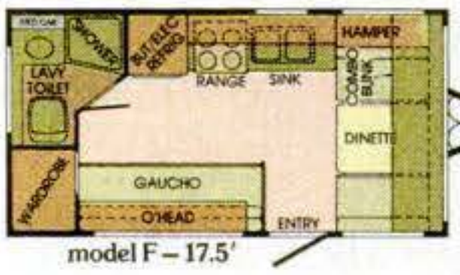
model N – 24.5'



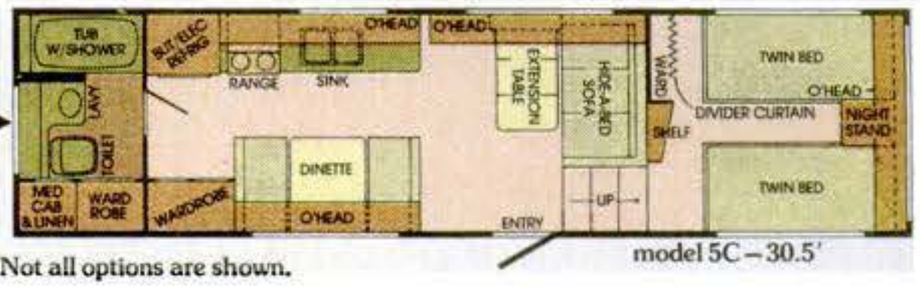
model 5B – 27.5'



model T – 31'



model F – 17.5'



model 5C – 30.5'

Not all options are shown.

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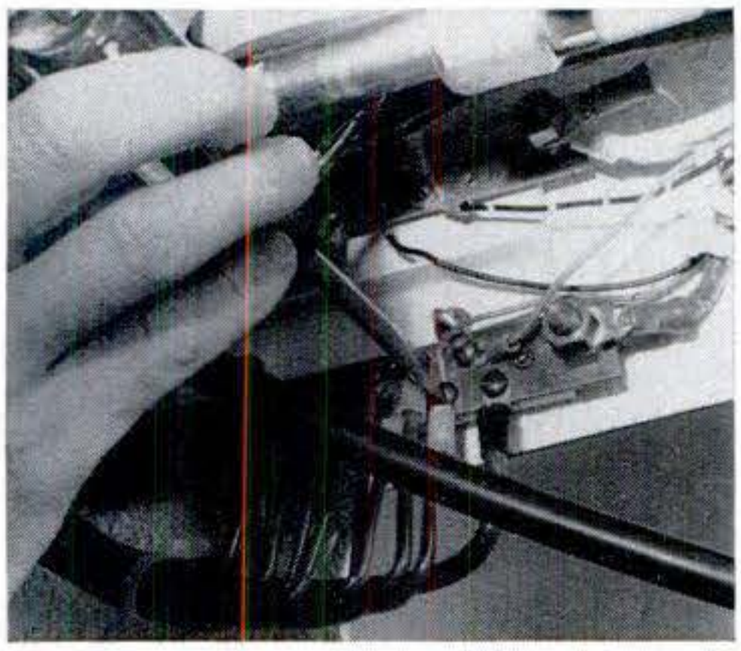
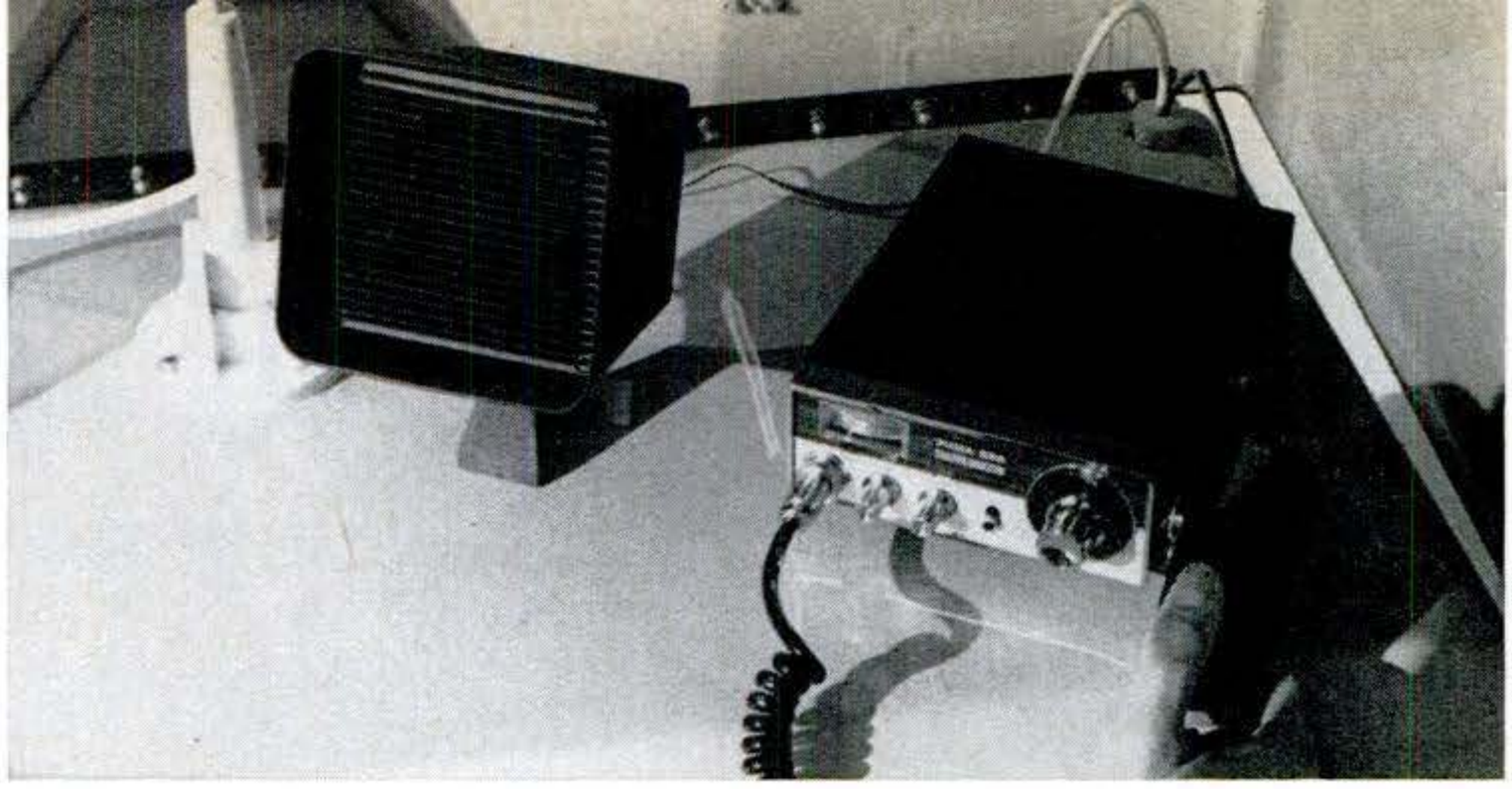




Power wires from rig connect to boat battery supply at main bus in instrument panel. Be sure black wire goes to negative bus; red to positive 12V.

Hand-tighten rig to mounting bracket. This allows quick-and-easy removal if you leave the boat. Windshield protects rig from water spray.

but you can also mount the unit permanently in the panel—or even below deck with just a remote speaker exposed for monitoring.

If you select an all-channel rig, you're well equipped. But, for the less expensive three- or six-channel models, be sure you have three crystals installed: channel 9 for emergencies, a second channel for the unofficial marine channel in your area (check with dealer), and a spare of your choice.

You can use any type of anti-theft mount you wish, but avoid wiring up the wiper connections on many of the slide-in mounts. The copper contacts will soon succumb to salt-air corrosion, making intermittent connections.

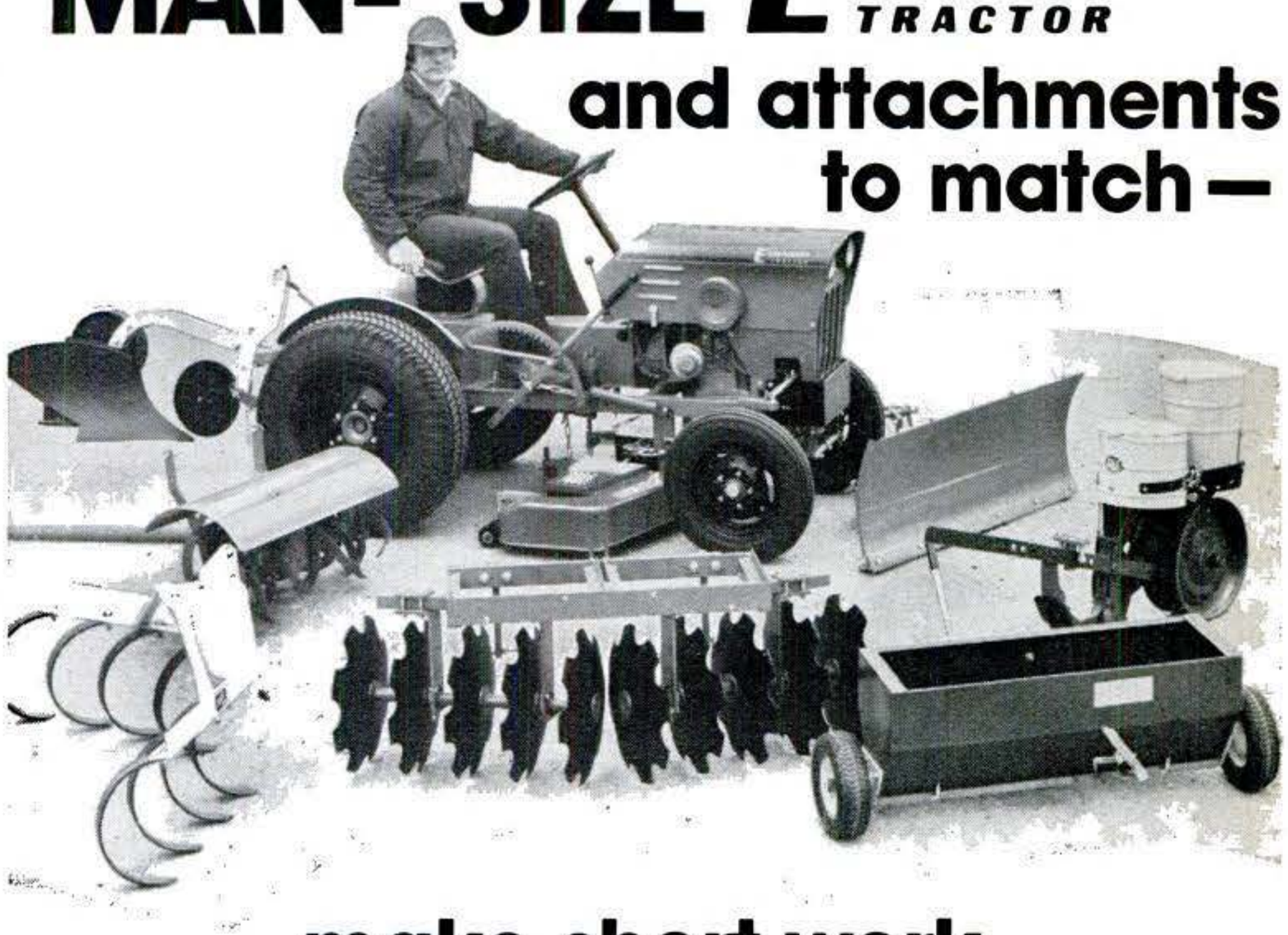
If you plan to use the rig while under way, you'll need a waterproof external speaker to hear calls above the motor noise.

Both positive and negative (ground) terminals must be connected to the 12-volt battery source. (Remember, the boat's fiberglass or wood body is not a conductor.) It's usually easier to connect these wires to some point in the instrument panel (red wire to positive 12 volts, black to negative; polarity switch, if one is present on set, to "negative ground" position). If, however, you notice ignition noise coming through the receiver, try connecting the power lines directly to the battery, instead. The low impedance of the battery will help shunt induced RF (radio frequency) ignition noise on the line to ground.

Contrary to popular belief, grounding an outside railing along the perimeter of the boat will not help create a "ground plane" effect for the antenna. Marine antennas are specifically designed to be used without a ground plane, and forming one, according to manufacturers, can actually hurt the proper signal characteristics of the system. Simply attach the connector to the rig. PS

MAN- SIZE ECONOMY TRACTOR

and attachments to match—



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Underwater flash

bright light in a small package

ve just had the opportunity to use e new Toshiba TM-1 underwa- r electronic flash on a half-dozen ves. And it seems to me that To- iba has put together just about l of the desirable features into e small, compact unit.

First thing I noticed when I got bolted onto my Nikonos camera its solidity. Many housings for gular strobe units are heavy, lky, and connected to the cam- a by a slender, shaky arm—that's t good when you launch yourself ckwards over the rail of a dive at into five-foot seas, wearing a ll wet suit and 80 pounds of gear.

The second thing I noticed was e fast recycling time—between ve and seven seconds on four fresh kaline double-A cells—and its gh light output. Guide number ith Kodachrome 25 is 41. Under- ater, I use Kodachrome 64 and ktachrome 64, and I've found a ide number of about 65 right.

But water itself is a powerful fil- r, and under most conditions, I've und, you have to crank in a filter ctor of about 4. That results in guide number of 16, which gives exposure of about F/16 at one ot—where I do most of my photo- aphy—F/8 at two feet, and F/6.3 three feet.

Some vital statistics: The TM-1 pressure-tested to 400 feet, gives ght coverage of 75° horizontal d 60° vertical. It weighs 2.4 unds in air, a few ounces under- ater. List price is $179.95. It's dis- ibuted in the U.S. by Elmo Mfg. o., 32-10 57th St., Woodside, N.Y. 377.—*C. P. Gilmore*

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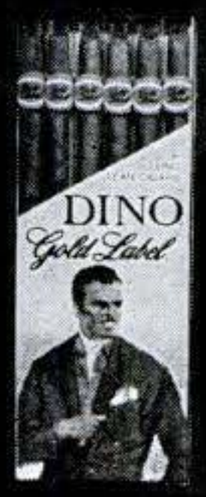

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Those work-saving, time-saving, problem solving **programmable calculators**

These new units work like an ultracompact computer. Should you own one?

By JOHN FREE

Whether you're a student tackling an assignment, a homeowner computing family finances, or a scientist solving complex integration problems, a hand-held programmable calculator will probably make your work easier, faster, and more accurate.

What sets pocket-size programmables apart from other calculators are the special storage registers built into them. These memory circuits can store the keystroke sequence needed to solve a formula. Once it's stored, all you do is enter the numbers for a problem, switch to the run mode, and let the calculator do the work. The program can be used repeatedly, and often eliminates dozens, hundreds, or even thousands of keystrokes in which errors might otherwise be introduced.

The hand-held models I've been using fall into three groups:

- Key programmables (volatile

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memory). Low in price ($30 to about $110), these have so-called volatile memories that are erased and lose the program when power is shut off. Programs are entered in the memories with a keystroke sequence.

- Card programmables. List-priced at $300 to $800 (but often discounted some 30 percent), these models can be operated just like the volatile-memory key programmables. However, after a program has been entered in the memory circuits, it can be stored permanently on a tiny magnetic card before you shut off the calculator. A built-in card reader can later read the program back into the memories in seconds. Manufacturers offer libraries of card programs (about $35 a set) in fields such as chemistry, navigation, or electrical engineering, plus specialized programs submitted by users.

- Key programmable (nonvolatile memory). In this latest version of the key system, shutting off the power does not erase the stored programs. A minute trickle of battery current to the memory circuits enables you to use the same program days or months later when you turn the calculator on again. Hewlett-Packard already offers such a nonvolatile memory, in its HP-25C. In March, the $395 model 7100 should join National Semiconductor's Novus line. In addition to a nonvolatile program memory, the 7100 uses plug-in cartridges containing a semiconductor memory instead of magnetic cards. These cartridges can store for years, without power, the programs you develop.

In addition to their programming capability, many of the models have preprogrammed scientific functions: log, trig, or polar/rectangular conversion, for example [PS, Nov. '76]. The number of preprogrammed functions ranges from about a dozen in Sinclair's Oxford 400 to 23 in TI's SR-52 and SR-56. Programmables, of course, can be used as ordinary (nonprogrammable) calculators.

Some models do not have preprogrammed scientific functions. Litronix's 2290 is a basic four-function model (with percent and memory) that can be programmed to run a 10-step sequence. The 100-step Novus line includes models preprogrammed with business (the 6025) and statistical (the 6035) functions.

Representative hand-held programmable calculators

	KEY PROGRAMMABLE								CARD PROGRAMMABLE		
	Sinclair Oxford 400	Litronix 2290	TI SR-56	Novus 6035 (statistical)	Novus 6025 (financial)	Novus 4515	Novus 4525	HP 25C	TI SR-52	HP-65	HP-67
Program steps	24	10	100	100	100	100	100	49	224	100	224
Branching			Yes					Yes	Yes	Yes	Yes
Addressable memories	1	1	10	1	1	1	1	8	22	9	26
Logic	RPN	ARTH	AOS	ARTH	ARTH	RPN	RPN	RPN	AOS	RPN	RPN
Stack registers (RPN)	1					3	4	4		4	4
Parenthesis levels			9						9		
Pending operations (AOS)									10		
Price ($)	30	30	110	75	75	70	75	200	300	795	450

Notes and addresses: Litronix's 2290 is a basic four-function calculator. The Novus 6025 and 6035 are nonscientific models and use ARTH (artithmetic) logic, with entries like those of business adding machines; all others have preprogrammed scientific functions. For details: Hewlett-Packard, 1501 Page Mill Rd., Palo Alto CA 94304; Litronix, 19000 Homestead Rd., Cupertino CA 95014; National Semiconductor (Novus), 1177 Kern Ave., Sunnyvale CA 94086; Sinclair, 375 Park Ave., New York NY 10022; Texas Instruments, Box 5012, 13500 N. Central Ex., Dallas TX 75222. Other manufacturers also have new models.

Keyboard entry

Most of the programmables use either algebraic or RPN computer-logic keyboard entry. (Texas Instruments calls its more elaborate algebraic technique AOS, for algebraic operating system.) Algebraic entry means that a problem may be entered just as it is written, from left to right. For complex problems, without AOS, this often means shifting intermediate answers into and out of memory. RPN entry logic works with a series of memory registers called a stack, and a key usually labeled ENTER. The stack automatically stores most intermediate answers for further processing, which simplifies complex work.

TI's new AOS system, however, seems to have advantages over both RPN and simple algebraic entry methods. AOS has a large number of parenthesis levels so that complex problems can be entered exactly as

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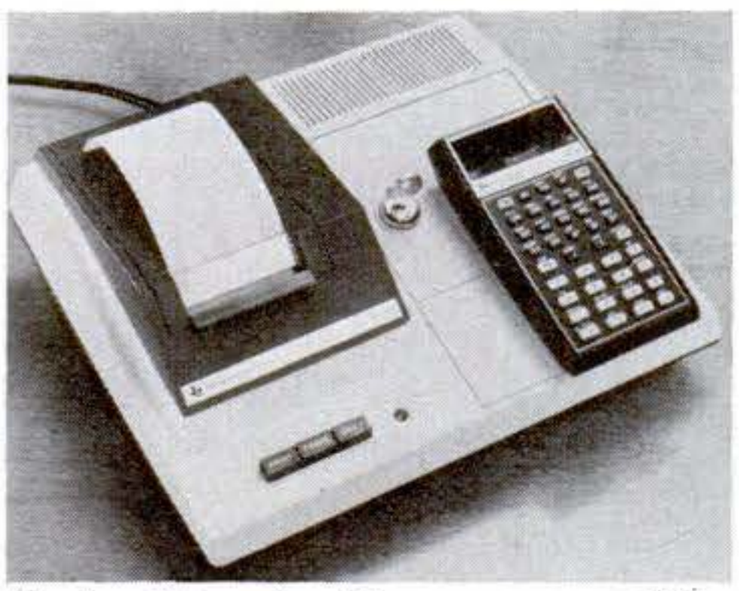

Moderately priced key programmables such as TI's SR-56 (left) boost the calculating ability of engineering or science students. TI's optional peripheral printer, the PC-100 (above), costs $295 and works with any TI hand-held programmable calculator. The silent printer uses 2.5-inch thermal tape. The first hand-held card-programmable, the HP-65 (right), offers advanced features and preprogrammed-card packages. (The HP-67, with more features, updates the 65.)

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written. For example, (5 + (8/(9−(2/(3 + 1))))) can be entered left to right. Intermediate answers to this problem appear as each closing parenthesis key is pushed; or, pushing the equal (=) key instead of the five closing parentheses gives the answer (5.941176471) immediately.

Various AOS calculator models from TI handle a variety of parenthesis levels (see chart) and keep track of the pending mathematical operations. Traditional methods of solving complex multilevel problems, with either RPN or basic algebraic logic, usually involve starting with the innermost set of parentheses and working to the outer ones.

The number of keystroke operations in a program can range from 10 with Litronix's 2290 to 224 steps with the SR-52 and HP-67 card programmables. At least 100 steps provide the leeway needed for the majority of programs.

Instructions for branching or transfer might tell the marker signal that sequences through each step to jump abruptly forward in the program. Intermediate answers throughout the program might be tested (whether they're equal to zero, for example) as a condition for branching. Among other things, branching enables you to obtain iterative (trial-and-error) solutions, or converge an answer to a specified tolerance.

The more complex models offer a variety of branch-related functions (looping, subroutines, flags, labels) that make them almost as versatile as early digital computers. Also included are editing features that sequence step-by-step through a program, allowing you to erase errors and insert corrections. Unless you're already familiar with computer programming, making full use of advanced programming features demands study and practice. PS

Two programs for key- and card-programmables

With the problem of calculating the surface area of Jupiter's 12 moons, you could, given each moon diameter, solve the formula for the surface area of a sphere, $A = \pi d^2$, 12 times. Here's how a keystroke-programmable, Hewlett-Packard's 25C (continuous memory), simplifies a tedious task and reduces the possibility of errors. As you'll see, the HP-25C differs from the HP-25 and most other key programmables.

PRESS **DISPLAY**
f, PRGM CLEAR **0 0**

The gold f shift key lets you select the program-clearing function of a three-function switch.

g **15**
With the 25C switched to ON and PRGM (program mode), the normal 0.00 standby readout becomes 0 0. The blue g shift key readies the 25C for the next entry: one of three possible functions on a three-way key. The digit 15 is a key code indicating that the g key is located in the first (top) row of seven rows and is the fifth key from the left. The 15 displayed is not the decimal fifteen.

x^2 **01 15 02**

The first program entry, for squaring diameters, is indicated by 01. Fifty possible steps are displayed as 01 through 49 as they are entered. The 15 mentioned above and 02 locate x^2 on the keyboard. When reviewing a program, 15 02 calls for pressing g (fifth key, first row), then 2, the second function of the decimal-2 key to obtain the x^2 function.

g, π **02 15 73**
The second step (02) in the program calls for pressing g (the 15 keycode) and π, the third key in the seventh row (73). The constant π is programmed in to 10 decimal places.

X **03 61**
The third step (03) is to multiply, programmed by pressing the first key in the sixth row (61).

GTO, 0 0 **04 13 00**
The fourth step (04) tells the HP-25C to go to (GTO) the first step (0 0) in the program. The GTO key is the third in the first row.

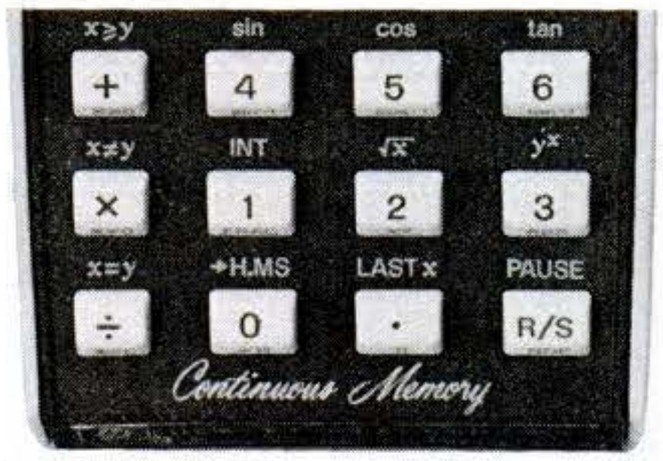
0.00
Switch the 25C to the RUN mode.

3200 **3200.**
The first entry is the diameter of the moon Ganymede in miles.
In RUN, the display appears similar to that in non-programmable calculators.

R/S **32169908.78**
After pushing RUN/STOP, the 25C sequences through the program, computing and displaying the area of Ganymede in square miles.

2310, R/S **16763852.56**
Similarly, the area of Io is displayed the instant you release the R/S key. Now suppose the telephone or study-period bell rings. You can shut the 25C off, pack it away in its case, and finish whenever you're ready.

1950, R/S **11945906.07**
When the 25C is turned on again, it's ready to go—you needn't reenter the program. This is Europa's area. The program memory draws a minute trickle of current even when



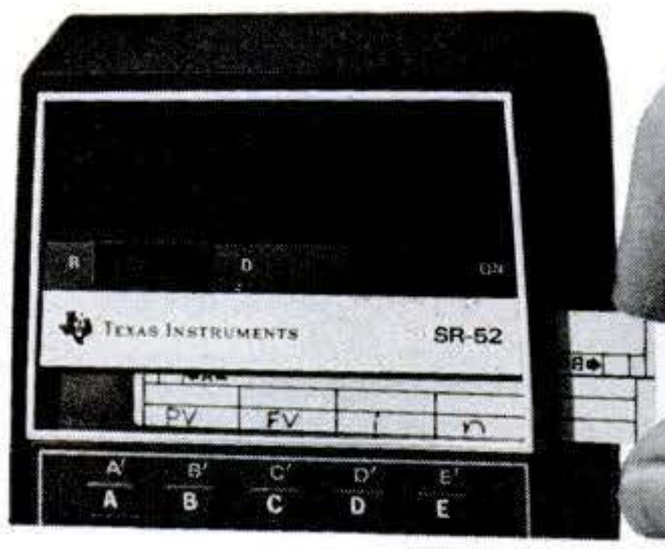
the unit is off. Of course, with conventional programmable models, such as the HP-25 ($145), turning the switch to OFF erases all electronic memories.

A more down-to-earth problem, involving interest on money you've deposited, can be quickly solved on TI's SR-52 card-programmable model by temporarily converting four of its five blank (user-defined) keys into financial functions. The formula to be programmed into the SR-52 is: $FV = PV\,(1 + i/100)^n$, where FV is the future value, PV is the present value, i is the interest rate per compounding period, and n is the number of compounding periods. Here's one key sequence possible:

PRESS
2nd, LBL, A, STO, 01, HLT
With the SR-52 in the learn mode, this key sequence is used to store the PV entry in the first (01) memory register. The 2nd or shift key enables you to select the second function of double-function keys. The A key has been labeled (LBL) to store values entered for PV; it is pressed after the entry. Programming halt (HLT) will stop the program at this point and automatically put the SR-52 in the calculate mode.

2nd, LBL, C, STO, 02, HLT
This sequence labels key C as the interest (i) key and stores the rate entered in register 02.

2nd, LBL, STO, 03, D, HLT
The D key is labeled for the number of compounding periods, stored in register 03. Keys



A, C, and D are now programmed to store the values of PV, i, and n into three memories.

2nd LBL, B, RCL, 01 X, (, 1, +, (, RCL, 02, ÷, 100,),), y^x, RCL, 03, =, HLT
This sequence stores the equation, recalling (RCL) values from the storage registers when needed. The B key is labeled as FV, the unknown element. Programming is now complete. After the sequence has been tested, it can be used to solve for FV as long as the SR-52 is left on, just like most key program-

mables. The entire programming sequence can also be stored on a blank magnetic card by pressing INV (inverse), 2nd, READ, and feeding the card into the lower slot. After the sequence is recorded, PV, FV, i, and n are written on card blanks. When slipped into the holding slot, the card identifies the A, B, C, and D key functions.

500, A, .4792, C, 24, D, B
For a test run, the values of PV ($500), i (.4792), and n (24) are entered in any order. Interest (5.75 percent) can be converted to the percent per compounding period by using the 52 (switched automatically to the calculate mode) to divide: 5.75 ÷ 12. The FV answer, $560.787147, is displayed when D is pressed.

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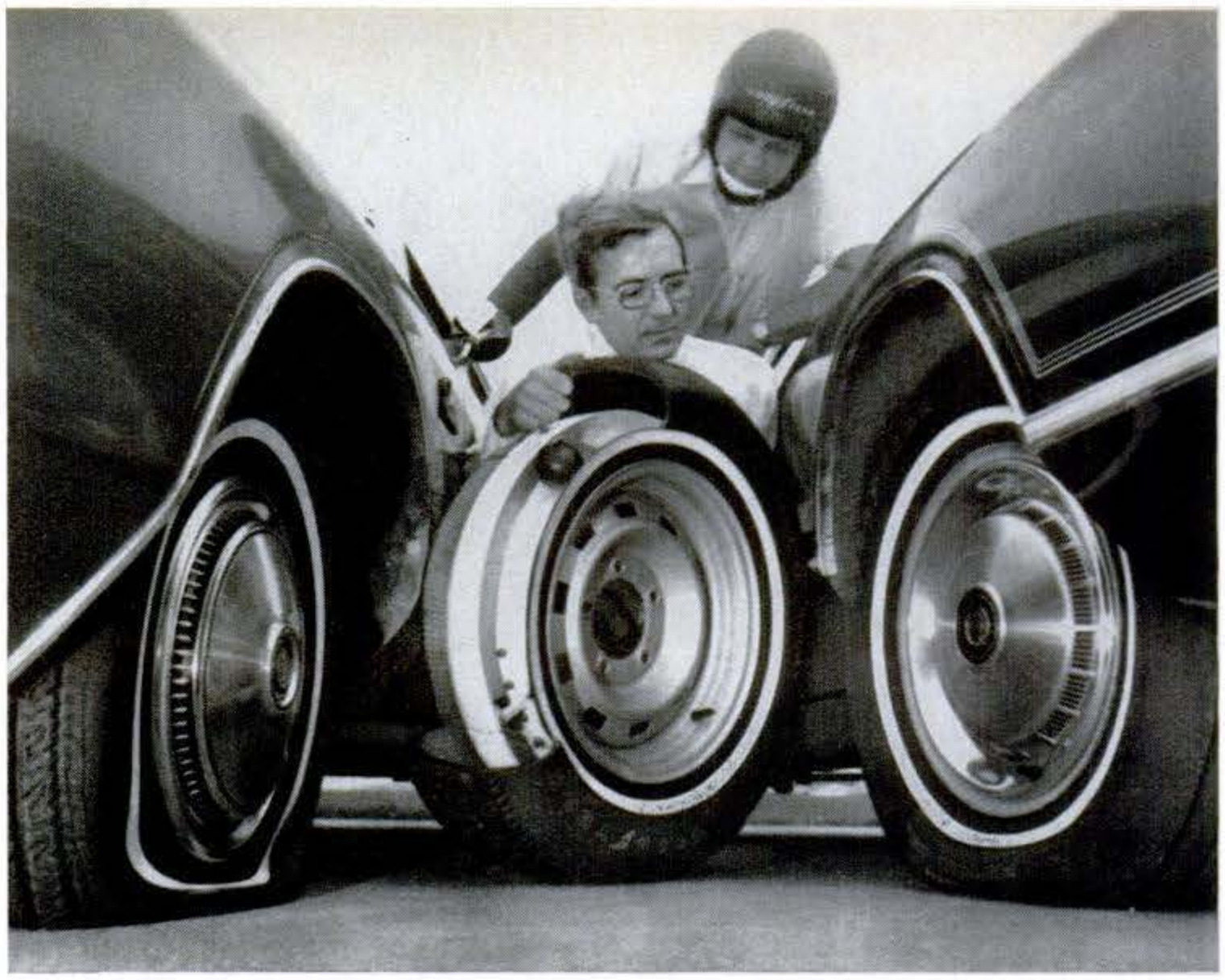


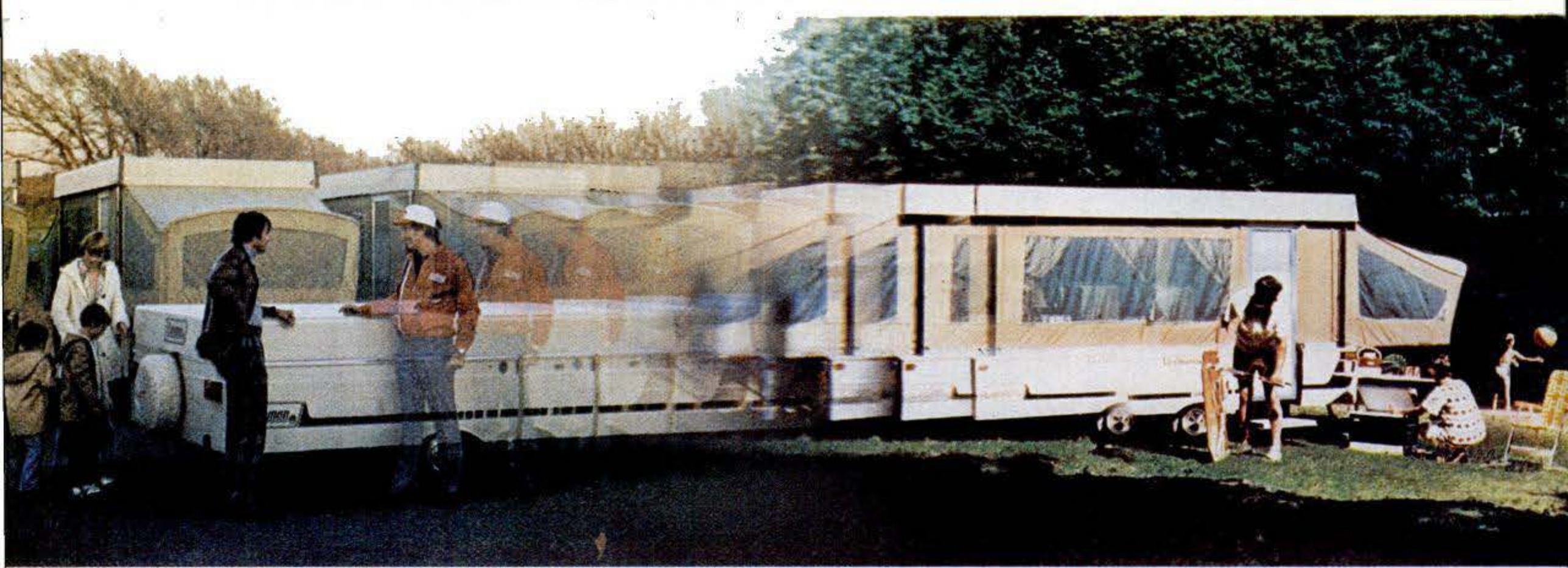
Someday you may be driving a car that doesn't have a spare tire. And if you have a flat, you'll simply drive—for up to 50 miles at up to 50 mph—to a service station to have it repaired.

Actually, your car may have four spare tires: reinforced fiberglass "inner tires," such as these developed by Goodyear. They are clamped around the inside of the regular wheels; then ordinary tires are mounted on the wheels (see cutaway tire in photo).

If an outer tire goes flat, the car's weight shifts to the inner tire, which rides about two inches below the outer tire's tread. A lubricant (in the "balloon" beneath the hand in the cutaway) is released inside the tire when it goes flat; it vaporizes to cool the tread that's pressed between the inner tire and the road.

The ride is so smooth with the run-flat device, says Goodyear, that engineers had to build in a gentle bump to let drivers know there's a flat. Although it may not feel like a flat, it will certainly look like one: The tire at left in the photo is riding on the run-flat device.

Each of the units weighs 12 pounds. Mounted on all four wheels of a standard car, they'll add less weight than a standard spare and they won't take up trunk space. Goodyear plans to field-test the tire after thousands of miles of run-flat testing in Akron.—*R. L. Stepler*



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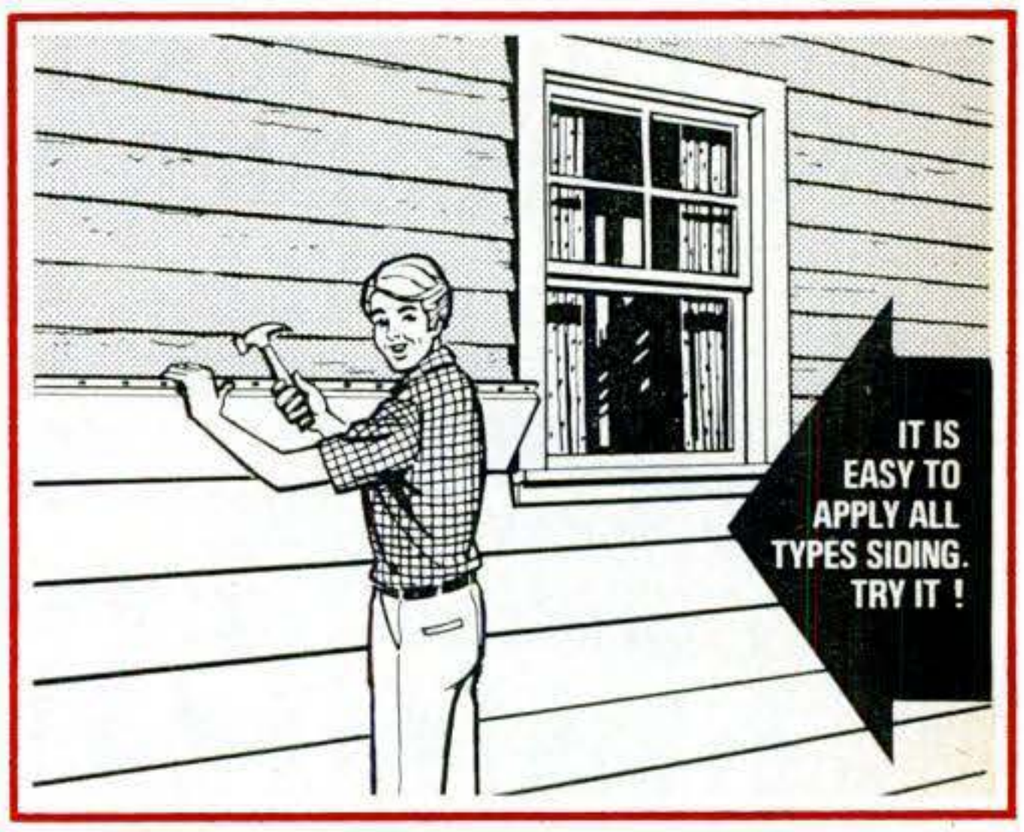

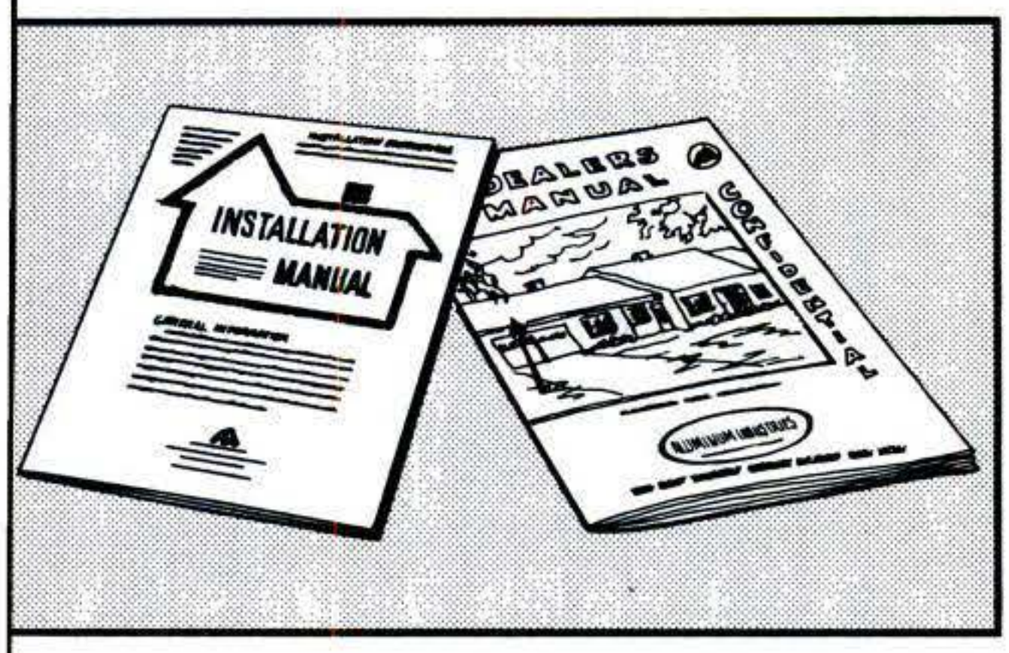

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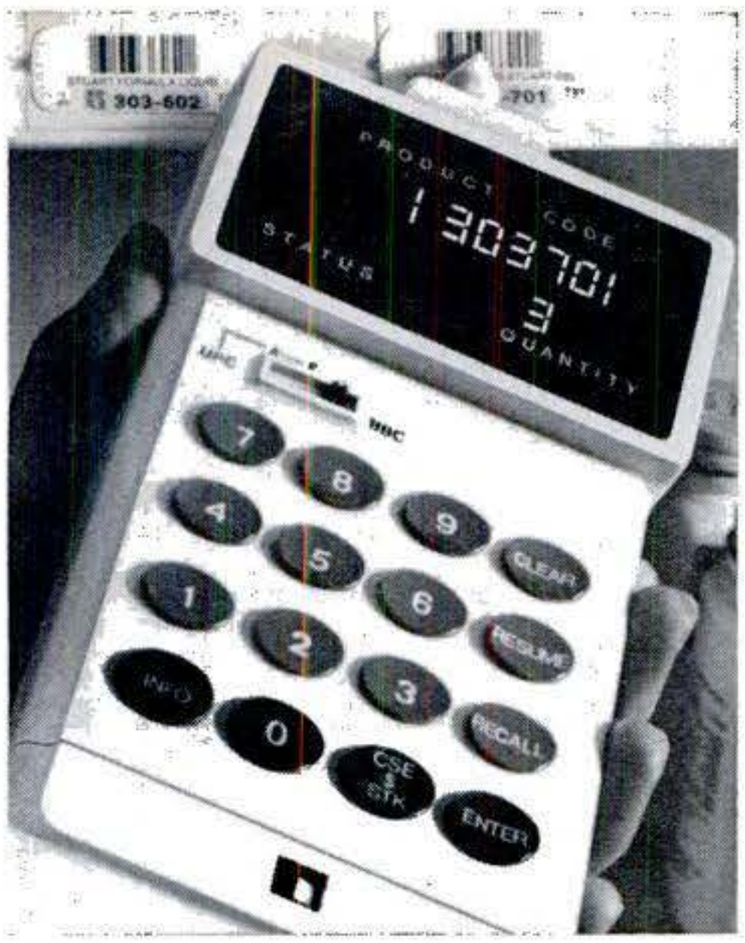

Tiny computer
made to order

The next time some computer short-circuits your charge account, the aspirin you take for the ensuing headache may also come to you via computer—and one not much larger than your pocket calculator.

A major drug distributor, Bergen Brunswig Corp. of Los Angeles, has established a reordering system that starts at your local drugstore with a hand-held 26-ounce microcomputer that can read the Universal Product Code—the black-and-white-striped patch on many supermarket items [PS, June '75]—and other bar codes.

To reorder an item, the druggist draws the microcomputer's optical probe across a bar-coded shelf label, and the code number of the item appears in the module's LED display. He then keys in the quantity he wants. The information is stored in the computer's memory pack. "Writing" an order takes only a little longer than walking up and down the aisles.

When he's finished the order (or when the memory pack's 400-line capacity is filled), the druggist removes the memory from the microcomputer and inserts it in a second piece of hardware, the service module. This transmits the order, over ordinary phone lines, to a receiving computer at a distribution center. Time: about five seconds.

Bergen Brunswig Dataservice, a subsidiary of the drug firm, developed the hardware and hopes to interest mass merchandisers, auto-supply outlets, supermarkets, and other retailers in the system. Price of the outfit—microcomputer, two memory packs, and service module—is $2950.—*V. Elaine Smay*

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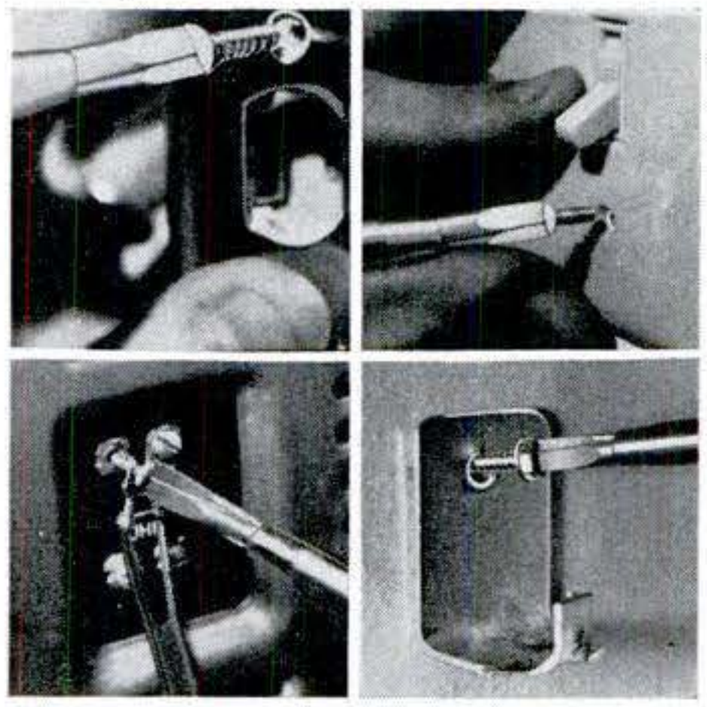

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Popular Science

PS | What's News

We've been seeing demonstrations of video-disc systems off and on for the past six years. But those were usually carefully staged shows with at least a couple of engineers in attendance to make sure everything worked right. Requests to operate the machines ourselves were politely declined. Now, we have finally laid hands on two machines with the invitation to use them just as we would in our living room.

Editor John Free had complete freedom to explore their capabilities while researching his article in this issue (p. 85). He reports: "Both the Philips and RCA machines are as easy to operate as your usual home record player—and the picture quality is superb. If you want a clue about my opinion of the future prospects, the video-switching panel I've assembled to handle my growing collection of video hardware has an empty input jack labeled 'Video Disc.' " For our cover photo, two other PS staffers, Elizabeth Bendall and Bill Hawkins, joined John in trying the Philips/Magnavox machine. Although they watched a number of recorded programs, the picture you see on the TV screen is faked — we couldn't resist showing a picture from another fascinating story in this issue (see p. 104) and we had no video-disc recording of it.

Small cars on ice

There's good news and bad news for small-car owners when it comes to driving on ice. The good news: A small car can stop in a shorter distance than a larger, heavier car. The bad news: Once stopped, lighter cars have more difficulty getting into motion again. That's the latest finding from the National Safety Council's annual winter-driving test program.

Report from Japan—Mazda GLC

I have just returned from a trip to Japan where I had the privilege of a preview/test drive of a remarkable new little Mazda from Toyo Kogyo. The Mazda GLC is designed to compete in the size class with such cars as the Honda Civic, VW Rabbit, and Chevette. We'll give you all the engineering details in a future issue, but I want to share a quick preview along with my personal impressions, because the concept runs counter to some popular trends in mini-car design.

While many of the more successful little imports have gone to front-wheel drive — some with transverse engine mounting—the GLC is entirely traditional with a four-cylinder, OHC piston engine in front, driving the rear wheels. When I first saw the specs on paper, I was disappointed. Had I come all the way to Japan to see another ho-hum little car? I have long been a booster of front-wheel drive, since the days when I was the proud owner of a 1937 Cord. In particular, I am convinced that this is the only way to go in a mini-car where every cubic inch of space is precious and the inherent stability of front-wheel drive is needed to offset some problems created by a short wheelbase and light weight. There you have the personal bias and preconceptions with which I approached my first drive in the GLC.

We were driven some 50 miles through the Japanese countryside from the main Toyo Kogyo plant in Hiroshima to the modern Miyoshi proving ground, where I got my first introduction to the GLC. From the outside, it has a clean, uncluttered, functional look. The total effect is pleasing to my eye, though it's not likely to turn heads in a line of traffic. My first pleasant surprise came when I tucked my six-foot-three frame into driving position. Entrance was easy and I didn't even knock my hat off getting in. There is comfortable leg and foot room—no intrusion from a wheel well, and reasonable clearance between the accelerator foot and transmission hump. The instrumentation and interior trim look quietly competent. There is a cheerful, functional appearance wherever the eye falls. Workmanship seems very good. And there's no hint of the feeling of austerity one gets from so many of these little economy cars.

I took the car out onto the high-speed loop and ran it up to about 80 mph. The noise level was surprisingly low for a four-cylinder, high-revving car. The ride felt secure and well-controlled. I tried zigzagging at that speed—gently at first, then building to rather violent maneuvers as my confidence in the car's handling grew. There was a reassuring sense of absolute control, with predictable response from every steering input. My respect for the engineering sophistication of the GLC mounted as I took it through the handling course of twisting, hilly roads, the rough-road test, and made a number of panic stops from high speed. When I finished driving, I had a lot of questions for the Toyo Kogyo engineers. You'll have to wait for our detailed story in a later issue for all their answers. The answers to my key question—"Why did they opt for conventional drive with a brand-new entrant in a hotly competitive market when most makers have conceded that front drive is the way to go for mini-cars?" — involve considerations of easy servicing, durability, weight distribution, maneuverability, and economy. No price has been posted on the GLC as yet, but unofficially I was told they hope to deliver it in the U.S. for about $3000, early this year.

Magnetohydrodynamics (MHD)

An important new technology for producing electricity directly from burning coal is wrapped around that jaw-breaking word. We first told you about it back in 1969 (June) and again reported on the latest research in March, 1974. This revolutionary new system can convert the energy in coal into electricity with far greater efficiency than any present system—some researchers say as much as 50 percent more electricity from a ton of coal than the best of the modern turbine/generator plants. Yet the "experts" managing our research efforts for long-range energy independence have largely ignored magnetohydrodynamics in the battle against dwindling petroleum supplies. Spurred possibly by the reports of the Soviets' success with their operating pilot plant, and certainly by the clamor of research scientists who realize its potential, ERDA is beginning to give more attention to MHD. General Electric, AVCO Corp., and Westinghouse have been selected to negotiate contracts to provide designs for an MHD pilot plant to test a system at the 200-300-megawatt thermal level. And three more contracts, totaling $7.2 million, have been awarded to the Montana Energy MHD Research and Development Institute, Leland Stanford University, and Reynolds Metals Company.

Hubert P. Luckett
Editor-in-Chief

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The strange world of **superpressure**

Ordinary materials can undergo extraordinary changes . . . if you just squeeze hard enough

By JOAN STEEN WILENTZ

I was standing in a laboratory at the National Bureau of Standards. On the counter was a collection of recording instruments and a TV tape and display unit hooked up to what looked like an ordinary microscope. But where the specimen slide would be was a metal slab with a hole in it.

I peered through the lens into the hole. Inside were two flat-headed diamonds, one above the other, a wafer-thin gasket between. The diamond was so pure I could focus through it to see there was something in the gasket: a sliver of transparent material. As I watched, the tip of the sliver darkened. The darkness spread, and in seconds the whole thing turned black. What I'd seen was a semiconductor in the act of becoming a real conductor: a single crystal of zinc sulfide transformed into dark metal. All it took was an enormous pinch of pressure, supplied by those very diamonds in a "diamond-anvil pressure cell"—some two million pounds per square inch.

That's superpressure. And the alchemy that transmutes pure semiconductors to base metals is just one of the many strange things that happen when you really put on the squeeze. The reverse can also happen: A good conductor can lose its current-carrying ability. Or more subtle changes can take place. Some superconductors—those metals or alloys that lose all resistance to the flow of current at temperatures close to absolute zero—change their transition point: Some superconduct at higher temperatures, given a pressure boost; some need to be even chillier.

It all has to do with what happens when you apply forces strong enough to push atoms around. At a certain point you get a change of state. That's familiar enough in terms of the baby temperatures,

Continued

GE's "diamond miner" Francis Bundy holds one of a pair of metal rings supporting a diamond-tipped piston at the center. Fitted into the hydraulic press at right, the pistons can generate pressures of eight million psi.

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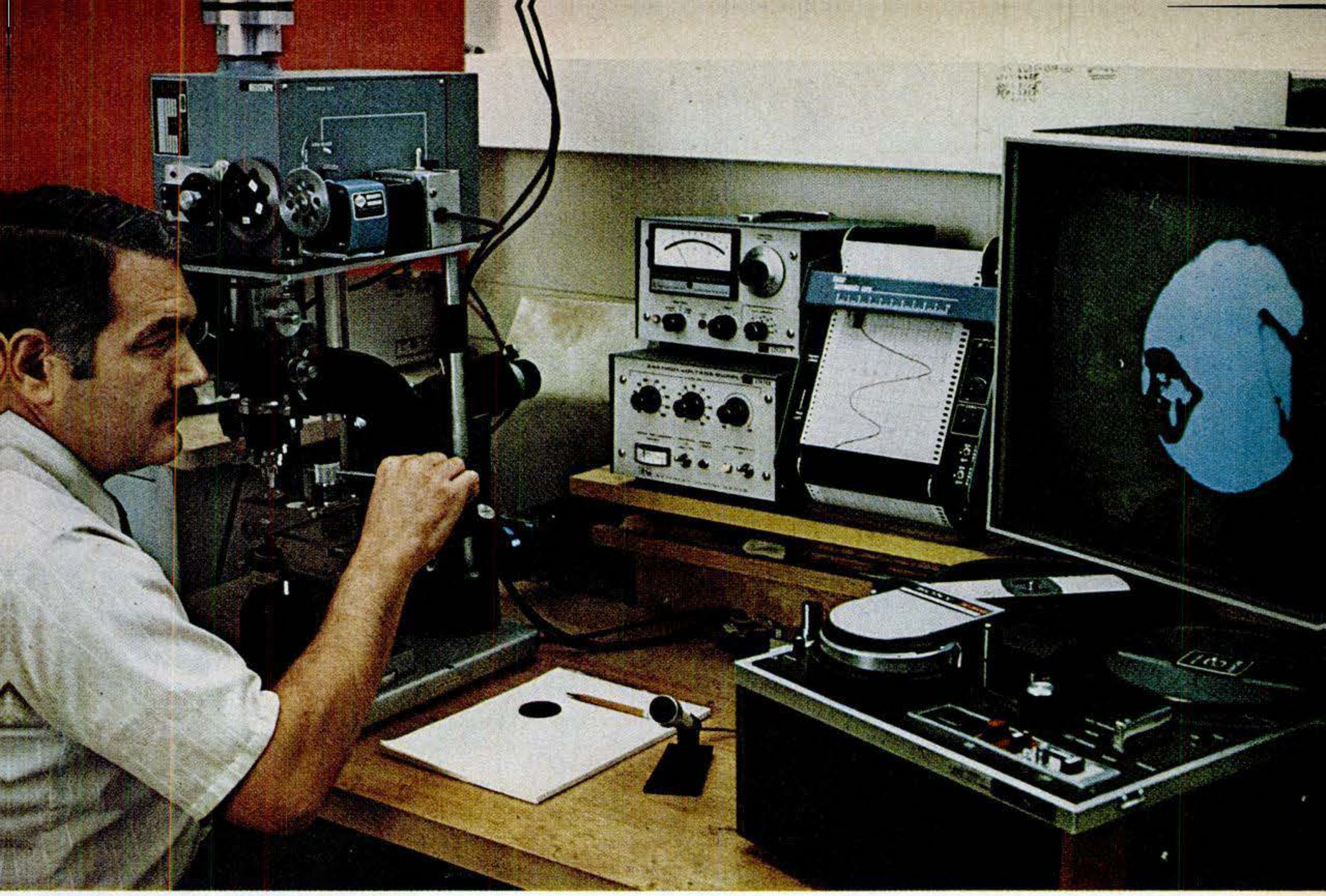

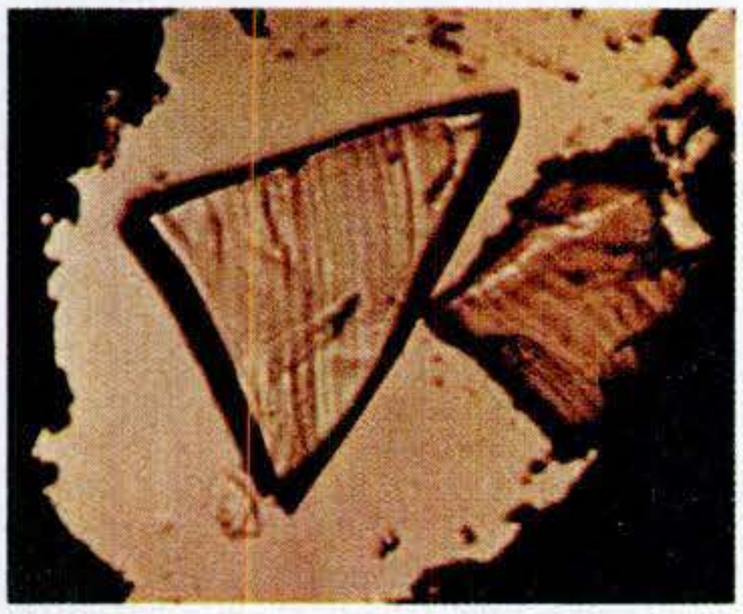

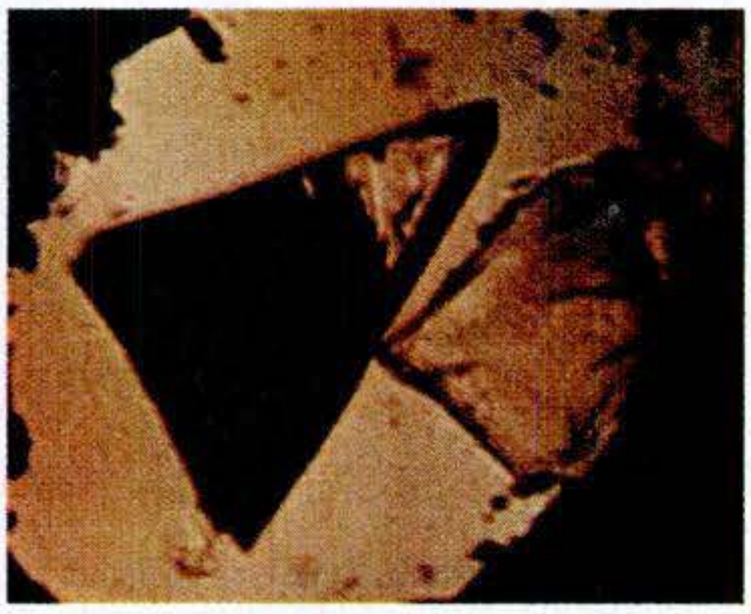

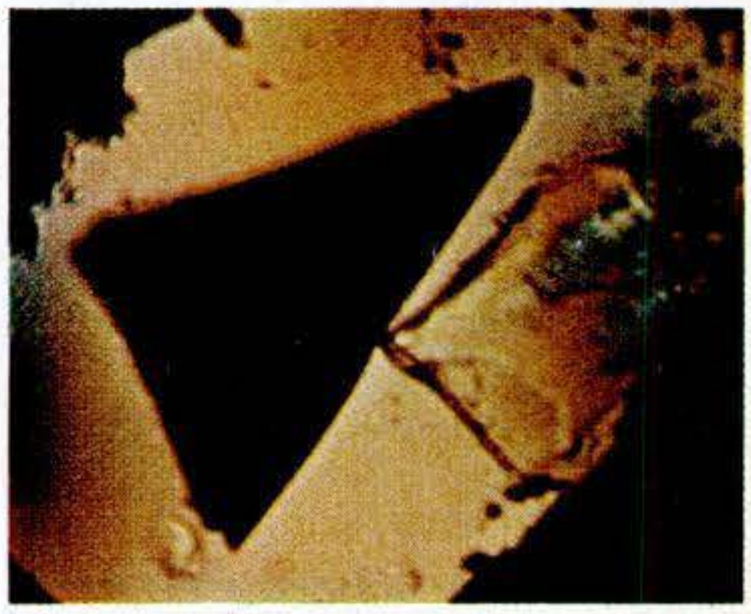

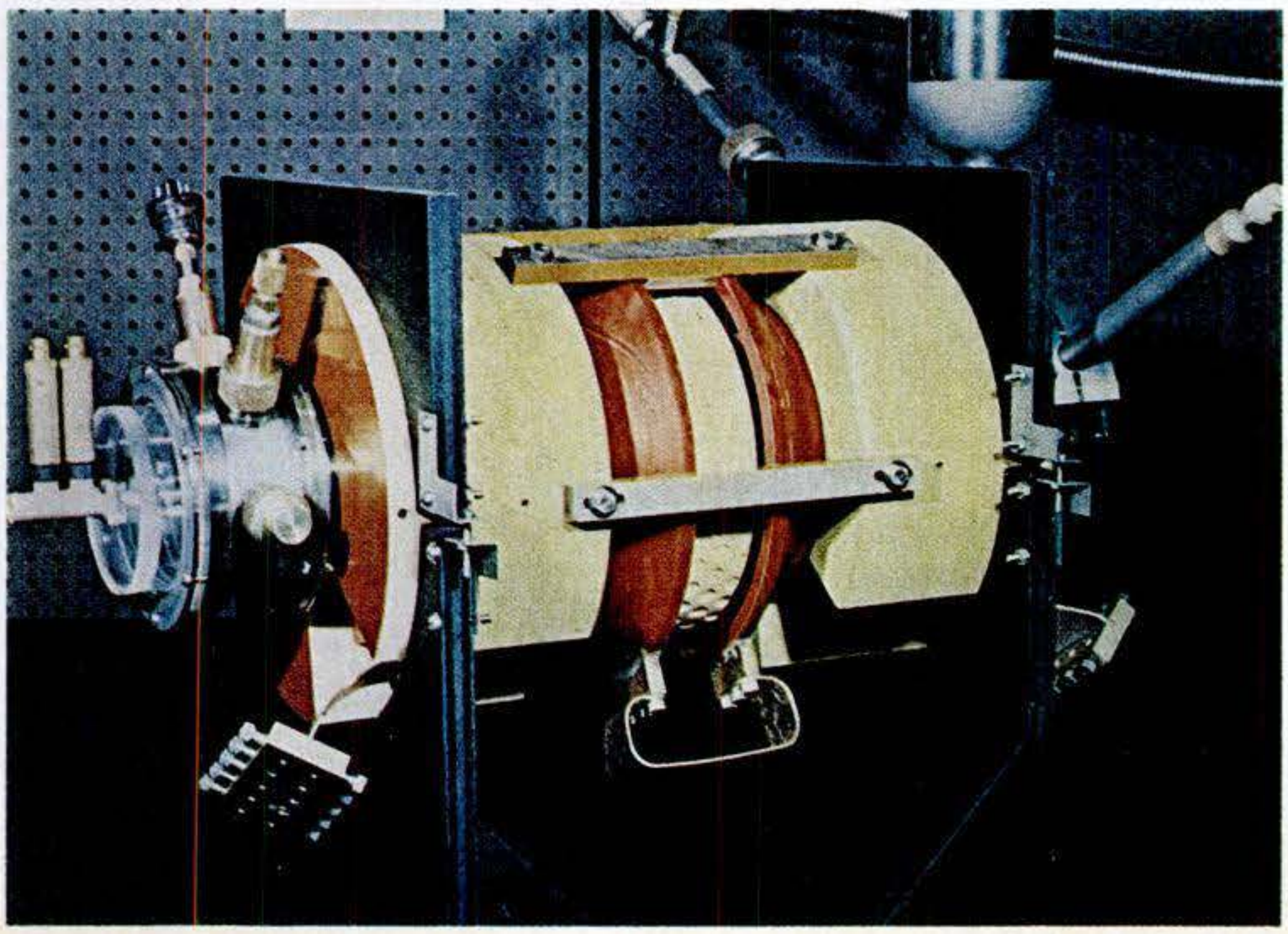

A turn of the rod, held by Gasper Piermarini, is all it takes to raise or lower pressure in the diamond-anvil cell developed at the National Bureau of Standards. The microscope is focused through the diamond to observe changes in the sample. At about two million pounds per square inch, zinc sulfide, a semiconductor, becomes metallic. Video display and photo sequence above record the change dramatically as the transparent triangular-shaped crystal suddenly turns opaque. Relaxing the pressure reverses the change. The smaller chip (at right in the photo sequence) is a ruby crystal, which monitors pressure and temperature changes in the cell.

"Big-bang" method was developed at Lawrence Livermore Laboratory. Explosives cause a steel cylinder to implode. This pushes the pressure generated by a magnetic field (red coils) into the megabar range, to make metallic hydrogen.

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pressures, and volumes at which water changes into ice or steam. What makes superpressure research so exciting today is that for the first time investigators have been able to push pressures into the megabar range and keep them there, obtaining pressures millions of times the normal atmospheric pressure of 14.7 pounds per square inch. You'd have to go deeper than a thousand miles underground to find equivalent naturally existing pressures.

With this means of mimicking nature, scientists hope to gain a new understanding of the origin of the solar system and the evolution of the earth. They dream of synthesizing new forms of matter or finding useful forms of old.

Graphite to diamond

Some of those dreams have already come true. More than 20 years ago, scientists at General Electric's Research and Development Center in Schenectady, N.Y., created the first man-made diamonds. They took ordinary "pencil-lead" graphite, subjected it to extremes of pressure and temperature—and got diamonds. Since then they have improved their techniques, to produce gem stones grown as single crystals. They even doped them with impurities to yield brilliant colors. Later, they synthesized a brand new substance, second only to diamond in hardness—cubic boron nitride. It's made by squeezing a substance similar in structure to graphite, known as "white graphite." Last summer, Francis Bundy, one of the original diamond miners (the GE lab, in the basement, is called the diamond mine), improved the apparatus to obtain pressures of eight million pounds per square inch (half a megabar). That's the equivalent, as the publicity people say, of "stacking four 50-ton locomotives end-to-end on the head of a tack."

Metallic hydrogen

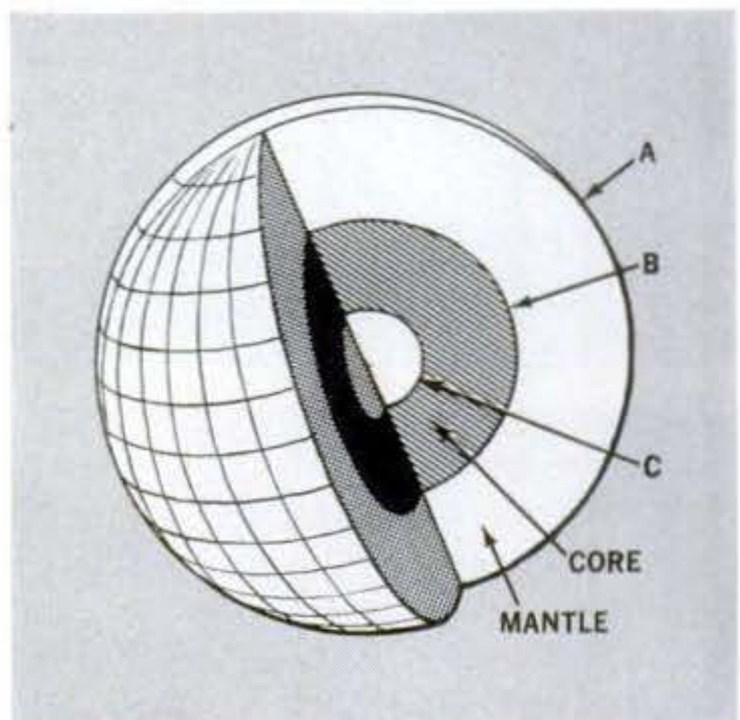
The energy crisis has focused attention on this lightest of elements as the ultimate in a cheap, clean, and efficient fuel. If only it could be tamed, teased from seawater, for example, and stored in convenient form—a pill for the gas tank, a nugget for the steam turbine. Metallic hydrogen may be the way to do it.

In theory, hydrogen should go metallic if pressed hard enough. Some laboratories here and in Russia and Japan believe they've managed this. But, to use Bundy's blunt phrase, "Will it stay squoze?" Can you bring the flower back from the hothouse to bloom at room pressure? There are reasons to believe that not only is this possible, but that as an added boon, metallic hydrogen would be a superconductor at room temperature. Not only would the utility executive have his cake, he could transmit across it, too.

Other allurements of superpressure research include the use of high pressure and laser heating as a way of handling ionized gases—deuterium or tritium plasma—in controlled fusion experiments [PS, Dec. '76]. High-pressure testing also serves the very practical need to know how materials behave under high stress; applications include explosives, jet-engine or rocketry hardware, alloys used for tools or dies, even lubricating oils. One recent study by Peter Lauer and M. Peterkin of Sun Oil Co., for example, was aimed at finding out what happens when lubricants stop lubricating. Such a state of "traction" can develop in oil under high pressure at a bearing contact. The traditional explanation was that traction occurred because brittle glassy particles would form. But it turns out that the oil still remains fluid, but forms a viscous sticky film in the region of the bearing contact.

Talk to crystallographers, spectroscopists, astronomers, atomic physicists about superpressure research and you find that what really brings the gleam to their eyes is the quest for basic knowledge. Just as temperature had earlier become a variable to juggle in studying the nature of matter, so now extremes of pressure can be manipulated. Already, this has enabled chemists to rewrite or extend their phase diagrams, those graphs that show at what pressures, temperatures, or volumes do substances change from solid to liquid or metal.

Thousands of tiny man-made diamonds are compacted to form the cone-shaped tip of the tungsten-carbide piston in GE's apparatus. Compacting makes superhard diamond even harder.



Superpressures on earth: Surface pressure (A) is a mere 1 bar. At the core-mantle interface (B), 2300 miles from the earth's center, pressure is 1.4-million bars. It rises to 2.5-million bars between the inner and outer core (C), 850 miles from the center; and reaches 3.5-million bars at dead center.

All these reasons added up to high interest in high pressure—even before the new technology arrived. A century or more ago, chemists knew that graphite and diamond were alternate forms (polymorphs) of the same element, carbon. What made graphite soft and black and diamond hard and clear were the different bonds and spatial arrangements of atoms in pure crystals of the substances. Push graphite atoms closer together and you'd get diamond.

Many tried to do just that. Harvard's pioneering high-pressure

Pressure: pascals and psi's

The new standard international unit for measuring pressure is the pascal:

1 pascal = 1 newton/meter^2

High-pressure people generally speak in bars, however, or kilobars (1000 bars) and megabars (1,000,000 bars). Translating, we have:

1 bar = 100,000 pascals
= 100,000 newtons/meter^2
= 1,000,000 dynes/cm^2

(on the metric scale).

One bar is also, but not quite, one atmosphere (atm):

1 bar = 0.9869 atm.

One atmosphere is the pressure that will support a column of mercury 760-mm high (29.92 inches) at 0°C and 45° latitude; that amounts to 101,325 pascals, or roughly 14.7 pounds per square inch. Clear?

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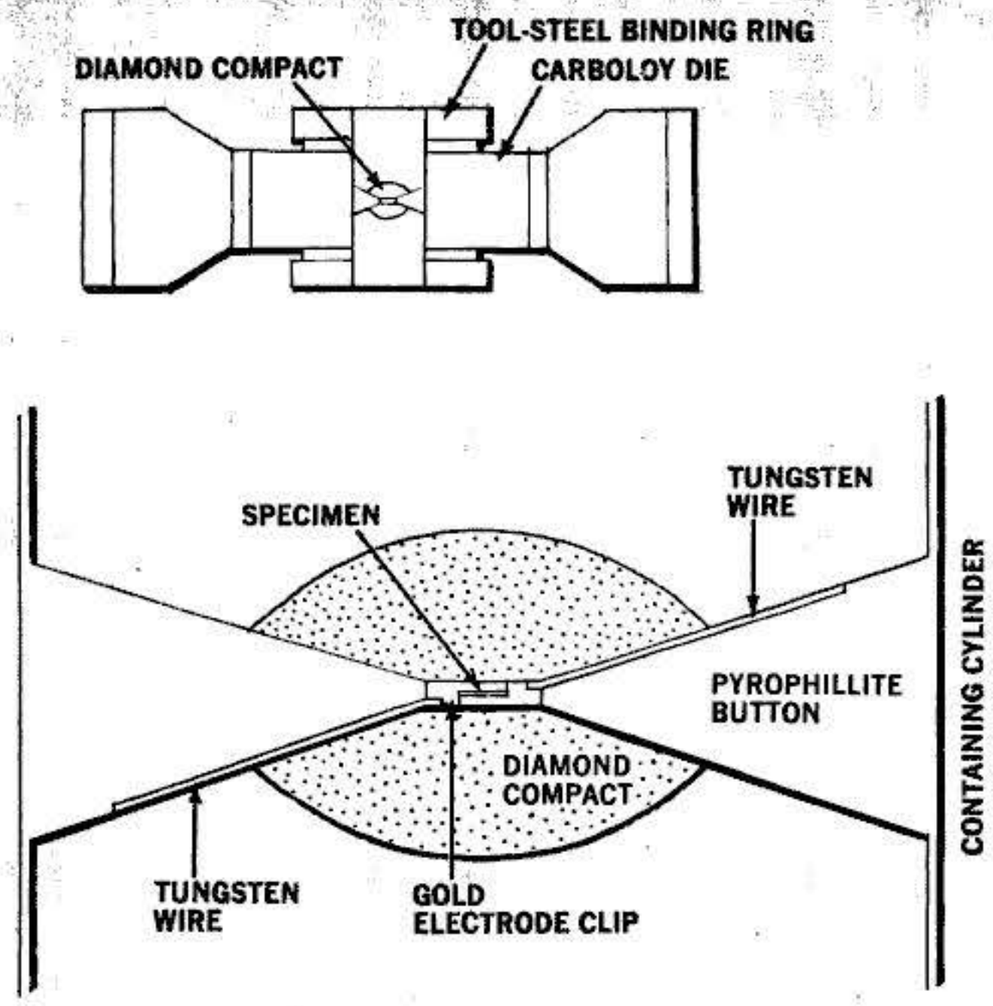
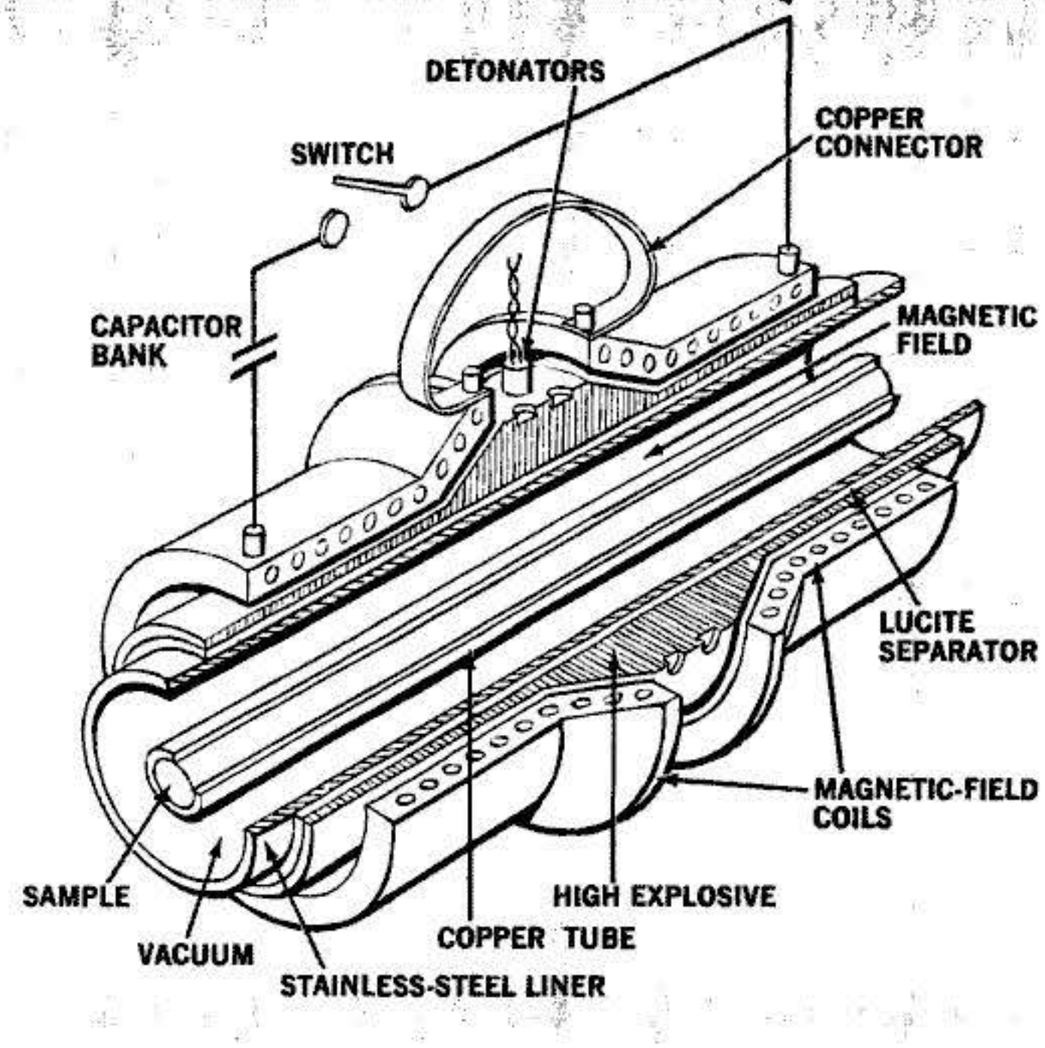
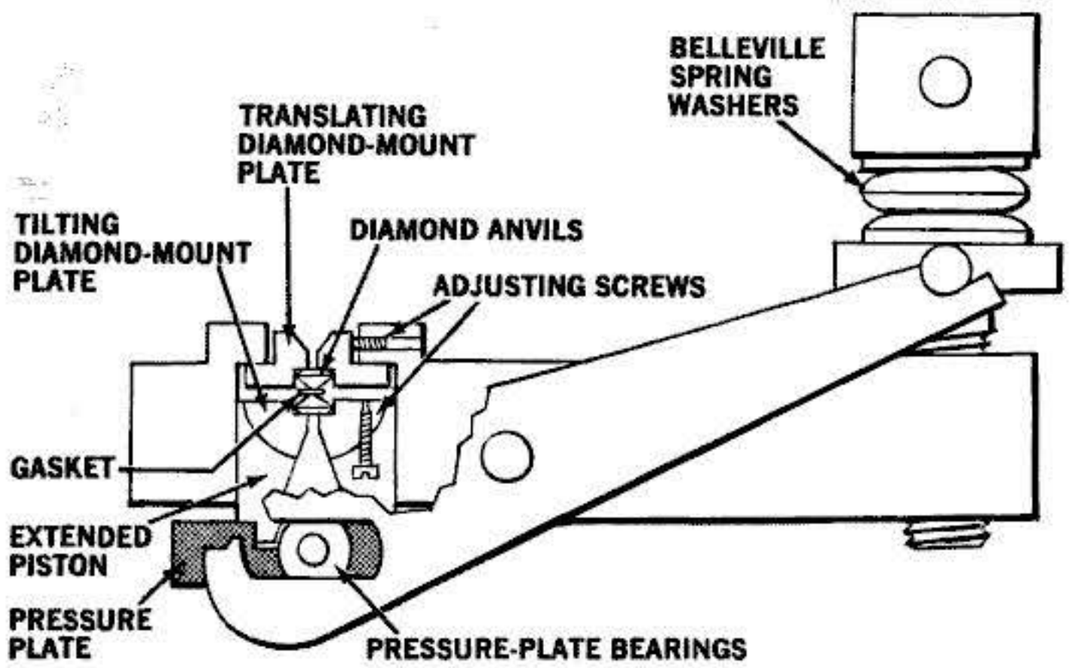
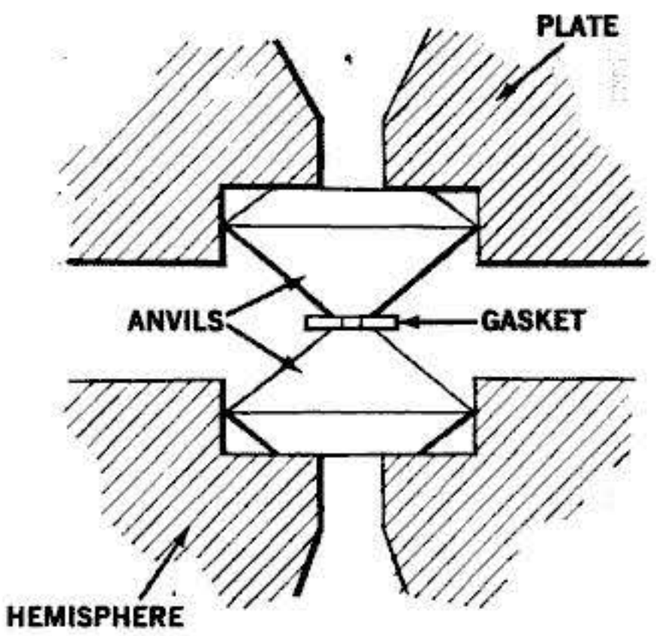


Concentric metal "doughnuts" support the pressure chamber in GE's apparatus, shown in cross section in upper drawing. Detail shows specimen cushioned by a pyrophyllite "button" gasket, a material that provides a smooth change of pressure along the piston's conical sides.



Magnetic-implosion technique developed at Lawrence Livermore Laboratory requires split-second timing. Just before detonation, capacitors discharge to set up a magnetic field in the space between the liner and the copper tube. Microseconds later, pressure climbs to the 10-megabar range.





Small enough to hold in your palm, the diamond-anvil cell generates superpressure by simple lever action. Compressing the Belleville washers forces the lever arm against the pressure plate. This force is greatly magnified over the much smaller area of the anvil surface. Detail, right, is metal gasket containing sample in position.

physicist, Percy Bridgman, came close. He tackled the root problem: How do you house your sample so that it, the container, or the experimenter, won't shatter when you turn up the pressure? It was clear that hard materials like tungsten carbide or diamond, flattened or gently rounded at the end, would be good candidates for piston heads in a hydraulic press. They are heroic under compressive forces, but they are not so good under shear forces. Bridgman reasoned that he would need massive side supports to equalize compressive and shear forces and so avoid the imbalance that leads to disaster. Further, the overall shape of the housing should approach a sphere.

The GE "belt"

It was a variation on the Bridgman design, which used concentric metal-binding rings—doughnuts surrounding doughnuts surrounding doughnuts—that GE scientists Bundy, H. Tracy Hall, Herbert Strong, and Robert Wentorf developed to bring off their diamond alchemy. The sample is placed in the "belt" in a metal gasket equipped with a furnace. That gasket can also be adapted to make electrical measurements. High pressures and temperatures can be maintained for long periods. It takes days to grow diamonds.

The belt design was not developed without trial and error—a euphemism for a nerve- and equipment-shattering event "that sounds like a 30-30 rifle report," says Robert Wentorf. The scars that deface the steel and three-inch safety glass surrounding the pressure chamber are mute evidence of past failures. They still talk about the time the thousand-ton hydraulic press got away: It dropped through the floor (fortunately injuring no one). Now they house their big press in a sub-basement on a reinforced floor.

I asked Wentorf what it was like when they were first perfecting the diamond-making process. When you open the chamber and see a flyspeck of matter, how do you know that you've in fact got diamond?

"It's the old principle that it takes a diamond to scratch a diamond," he said.

"But how do you scratch with such a tiny particle?" I asked.

He smiled. "It's not easy. First you have to pick it up. You use a needle or a pin and try to get the speck to stick to the point. Rubbing the needle on your skin to pick up a little oil helps. Then you have to get the sample onto a small test block; a surface of diamond. If you can't shake the sample off, you can drop a bit of solvent to break the adhesion and get the speck on the block. Then you take an ordinary microscope slide, being careful to breathe on it first to remove any static electricity, and place the slide over the sample on the block. Now you press down, moving the slide firmly across the diamond surface. When you lift the slide you hope you find a scratch. But you'd better rub your finger over it to make sure you haven't got just a bit of pulverized dust. If you

[*Continued on page 137*]

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Ice-block house

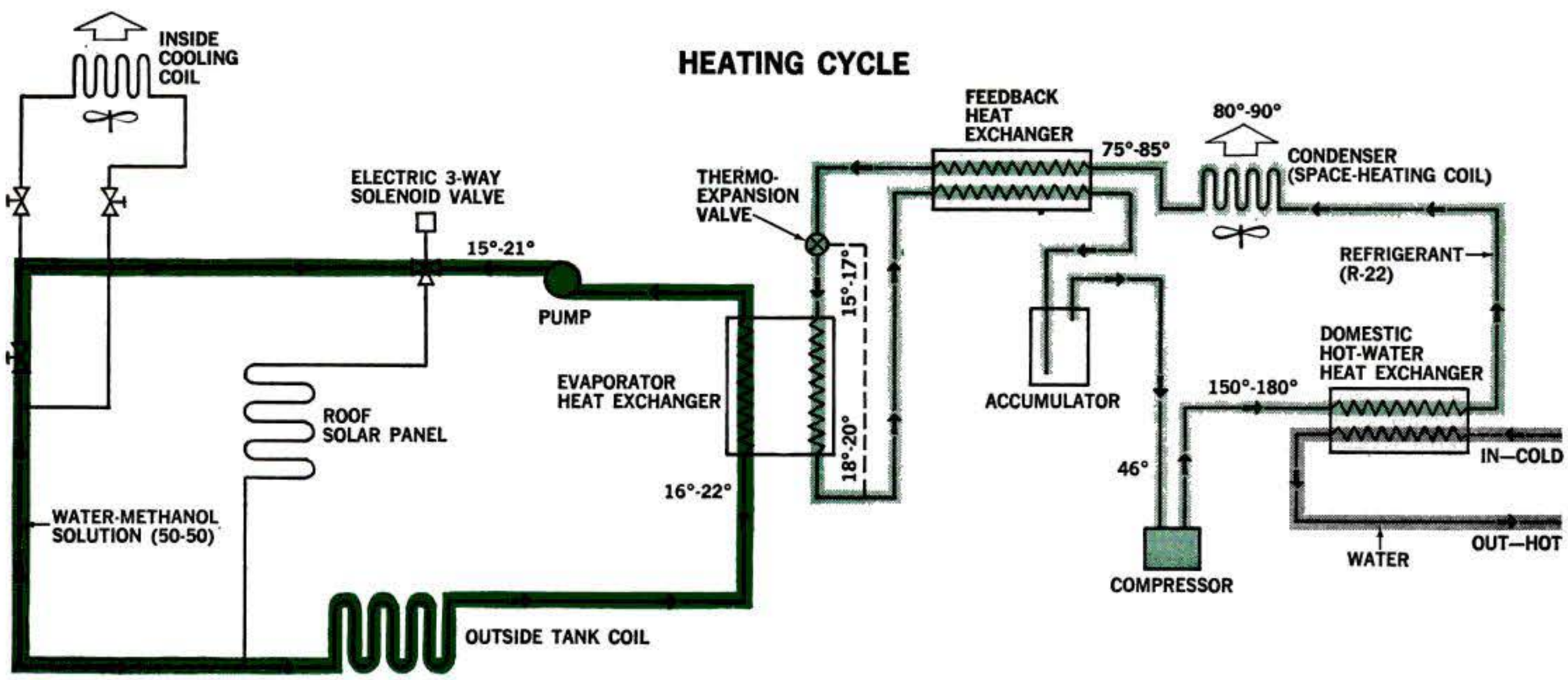
—winter's heating creates summer cooling

By V. ELAINE SMAY

"This is going to be a scorcher," said the taxi driver as she squinted up at the pale sky. We were bumping along in her battered Checker cab, traveling from downtown Pittsburgh to a Westinghouse research and development center about 20 minutes away. At the end of the ride came a quarter-mile walk to Homelab, a small ranch-style house where Westinghouse tests all kinds of experimental systems.

After a long, hot trip, it felt so good inside the little test house. The temperature was a comfortable 70°, the humidity 50 percent—just what a properly air-conditioned house ought to be. But Homelab isn't really air-conditioned—at least not in the normal sense. This house keeps its cool because buried just outside the living room is a gigantic ice cube 20 feet square and four feet deep.

Homelab's ice cube is part of a novel heating and cooling system called ACES (annual cycle energy system). The concept is based on the fact that in much of the U.S., the heat you have to get rid of to be comfortable in the summer is just about equal to what you must add to be warm in winter. ACES takes advantage of this annual weather cycle by removing heat from a large tank of water for winter's heating; this turns the water into ice, which is stored for cooling the house in summer. Since heat is *stored*, not created—as it is when you burn fuel to heat your house, or when the



ACES heating cycle (above) consists of a methanol-water loop, a refrigerant loop, and a loop for domestic hot water. Here's how it works: The methanol-water solution is pumped through the finned tubing in the water tank, where it picks up heat from the freezing water (see text). Then it enters the evaporator heat exchanger, where it transfers heat to the refrigerant, a fluid that boils at a low temperature. The refrigerant is at a very low pressure, which further reduces its boiling point. Although its temperature at this point is only 15° to 20° F, the refrigerant is boiled by the heat extracted from the methanol solution. The methanol then flows back to the water tank to pick up more heat. Meanwhile, the refrigerant goes into a feedback heat exchanger where it absorbs more heat. (The accumulator provides for expansion and contraction of the system.) The refrigerant next enters the compressor, where both its temperature and pressure are greatly elevated. This hot gas is sent to a heat exchanger to provide the domestic hot water. The refrigerant then flows through the condenser (the space-

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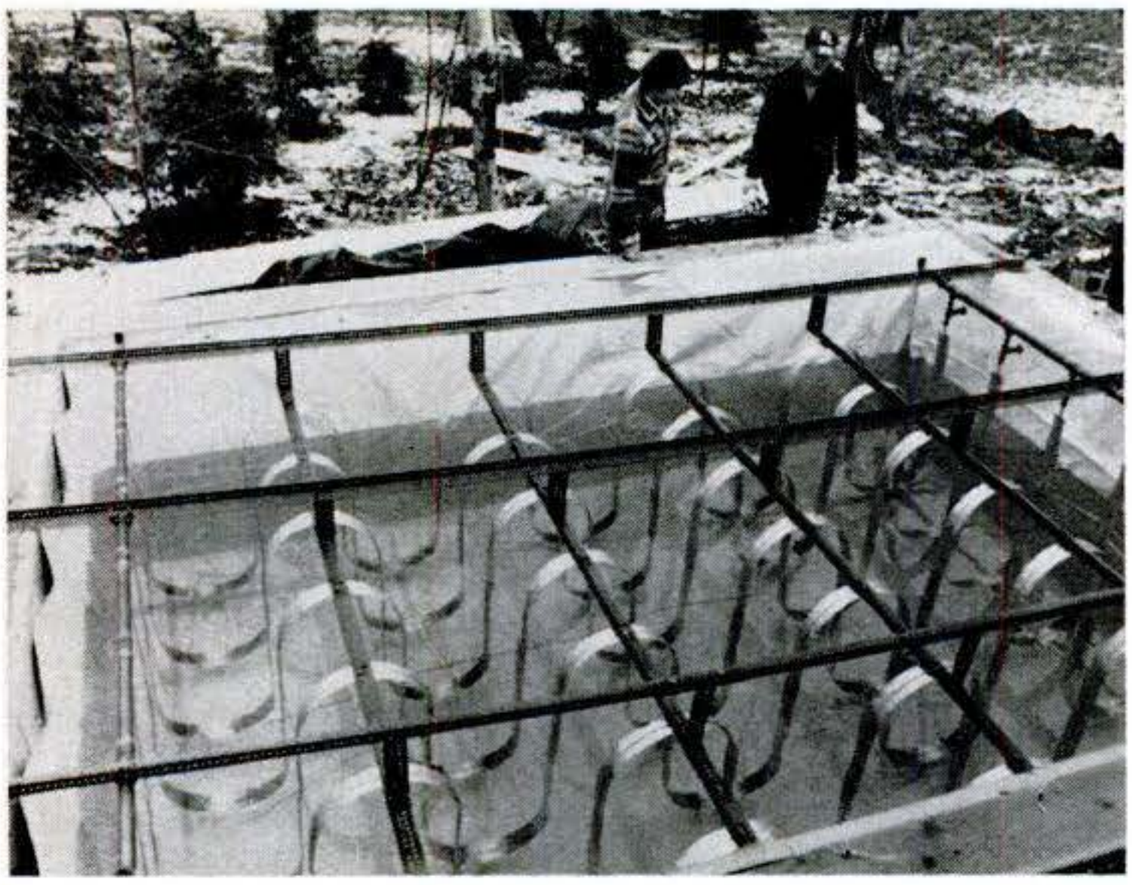
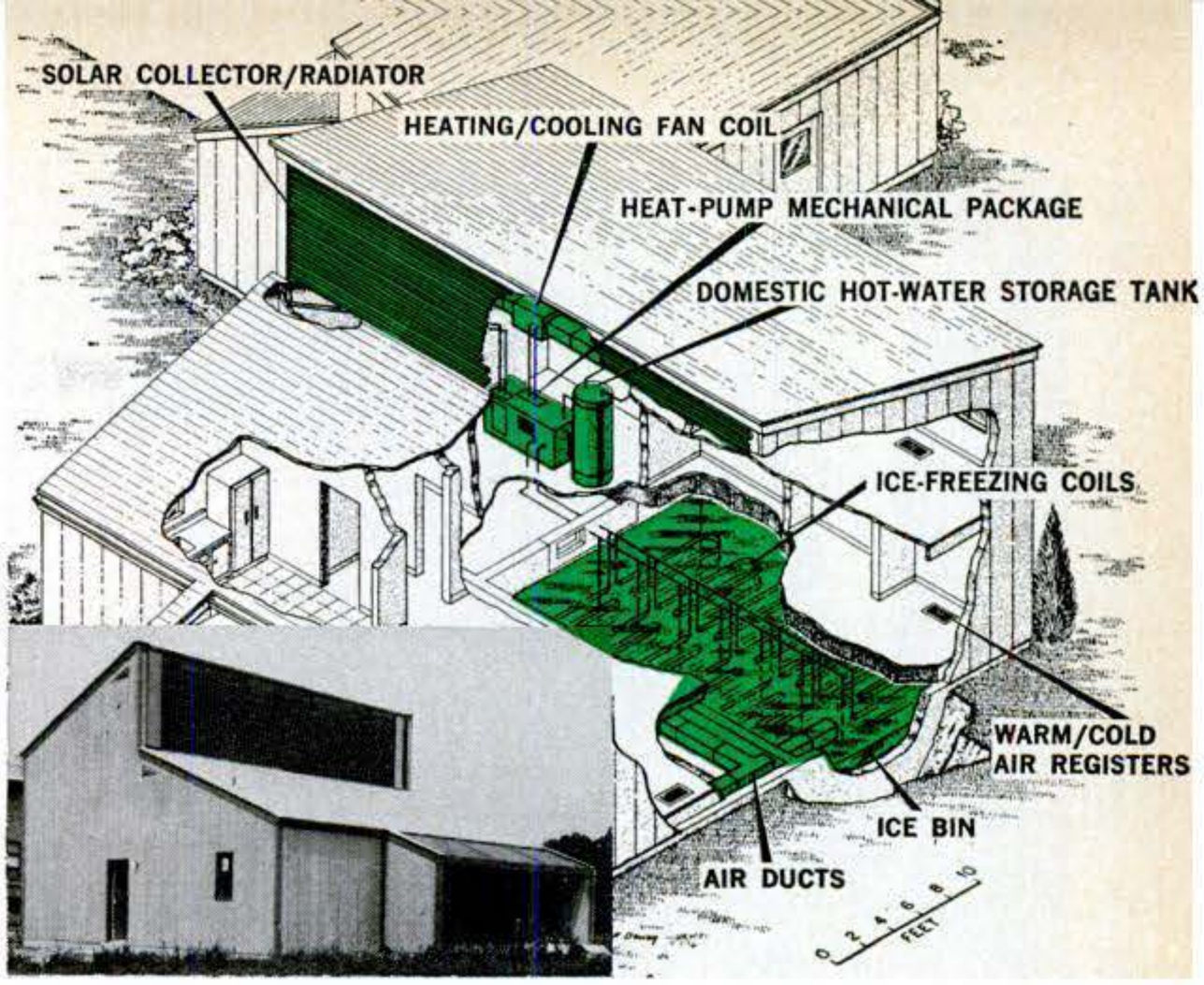


Finned tubing, 364 feet of it, snakes across 1600-cubic-foot water tank at Westinghouse installation. Tank has sand bottom, concrete-block walls with two-inch styrofoam insulation, vinyl liner, and heavily insulated lid.



Cutaway of ACES house shows where all systems are located. Note venetian-blind appearance of solar collector/radiator (inset). Insulation and 11-percent fenestration cut energy needs in half. Knoxville demonstration house is open to public.

power plant burns it to make electricity—heating and cooling your home take far less energy.

The ACES concept didn't begin at Westinghouse. It started in the head of Harry C. Fischer, an energetic chemical engineer with 30 years' experience in the heating and air-conditioning field. Fischer first got the idea in the 1950's, but energy was too cheap then for the concept to be economically sound. So he filed it away until the 1970's brought oil embargoes, soaring energy prices, and an alteration in our thinking.

"With an ACES, the average home should save from 60 to 75 percent in heating and cooling costs," says Fischer. In today's economy, that's got to sound good to just about anyone. It certainly did to John Moyers, a soft-spoken man with a slight southern accent who heads ERDA's residential energy-conservation program at Union Carbide's plant at Oak Ridge National Laboratory. So ACES became the first development project to be funded by ERDA's new division of buildings and community systems, and Fischer came out of semiretirement to work on his idea as a consultant at Oak Ridge. Meanwhile, Westinghouse got word of the ACES concept and decided to install one in Pittsburgh.

As I quickly discovered at Homelab, ACES doesn't involve exotic new technology. In fact, similar systems have been in use in Japan since the 1930's; Fischer learned of

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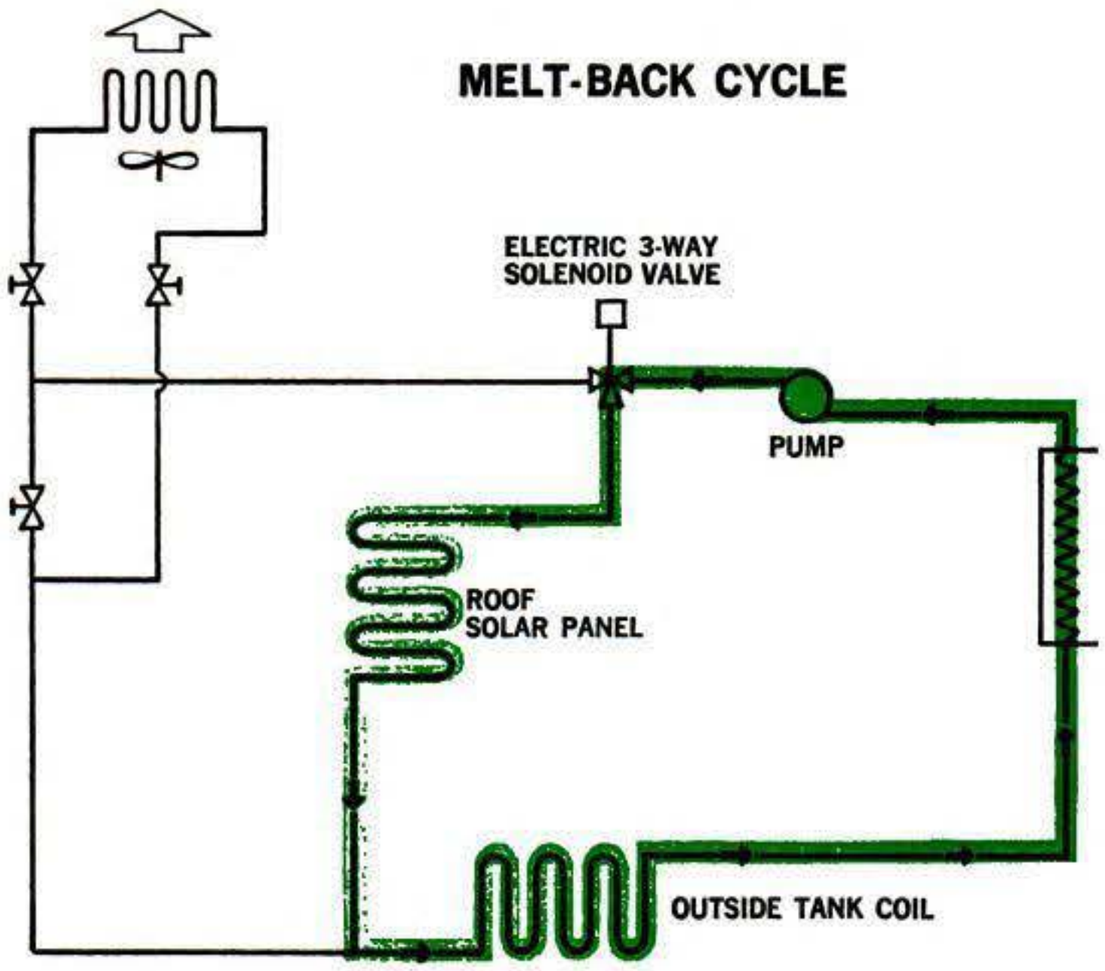

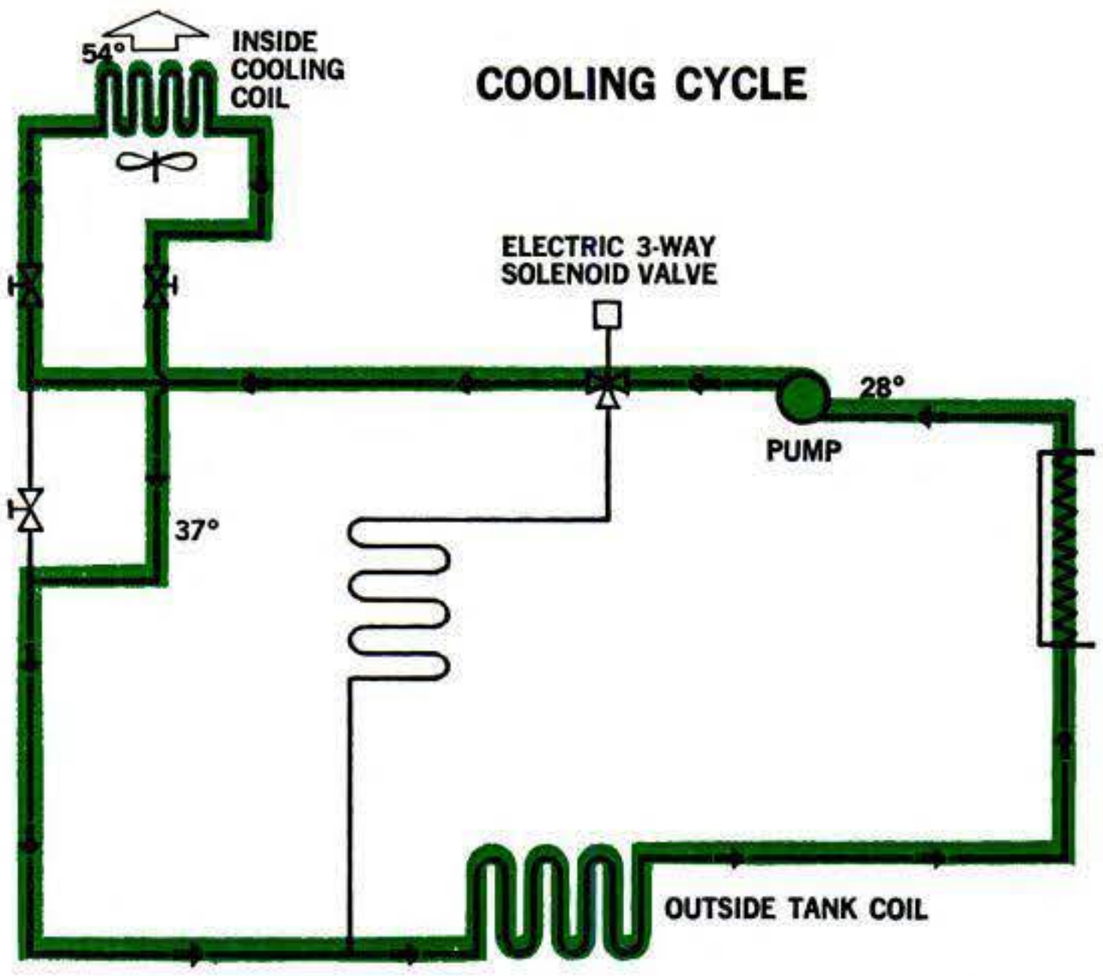

heating coil). A fan blows air over the condenser; the hot gas gives up some of its heat and condenses into a liquid. The air blowing over the condenser is thus warmed, and circulates through the ducts to heat the house. The still-warm liquid refrigerant travels through the feedback heat exchanger to help heat the incoming refrigerant about to enter the compressor. Then the returning refrigerant passes through an expansion valve, its pressure and temperature fall sharply, and it begins to boil. The cycle repeats. **In the melt-back cycle** (center), the methanol-water solution is sent through solar collectors on the roof, then back through the water tank to melt some of the ice. It's used where winter heating needs exceed summer cooling needs. By melting some of the ice, you keep the tank from freezing solid, and thus avoid a larger tank. **For summer cooling** (right), the methanol solution circulates through the coils in the ice-filled tank, then through the inside cooling coil, where a fan blows air across the cool coils and circulates it through the ducts to cool the house.

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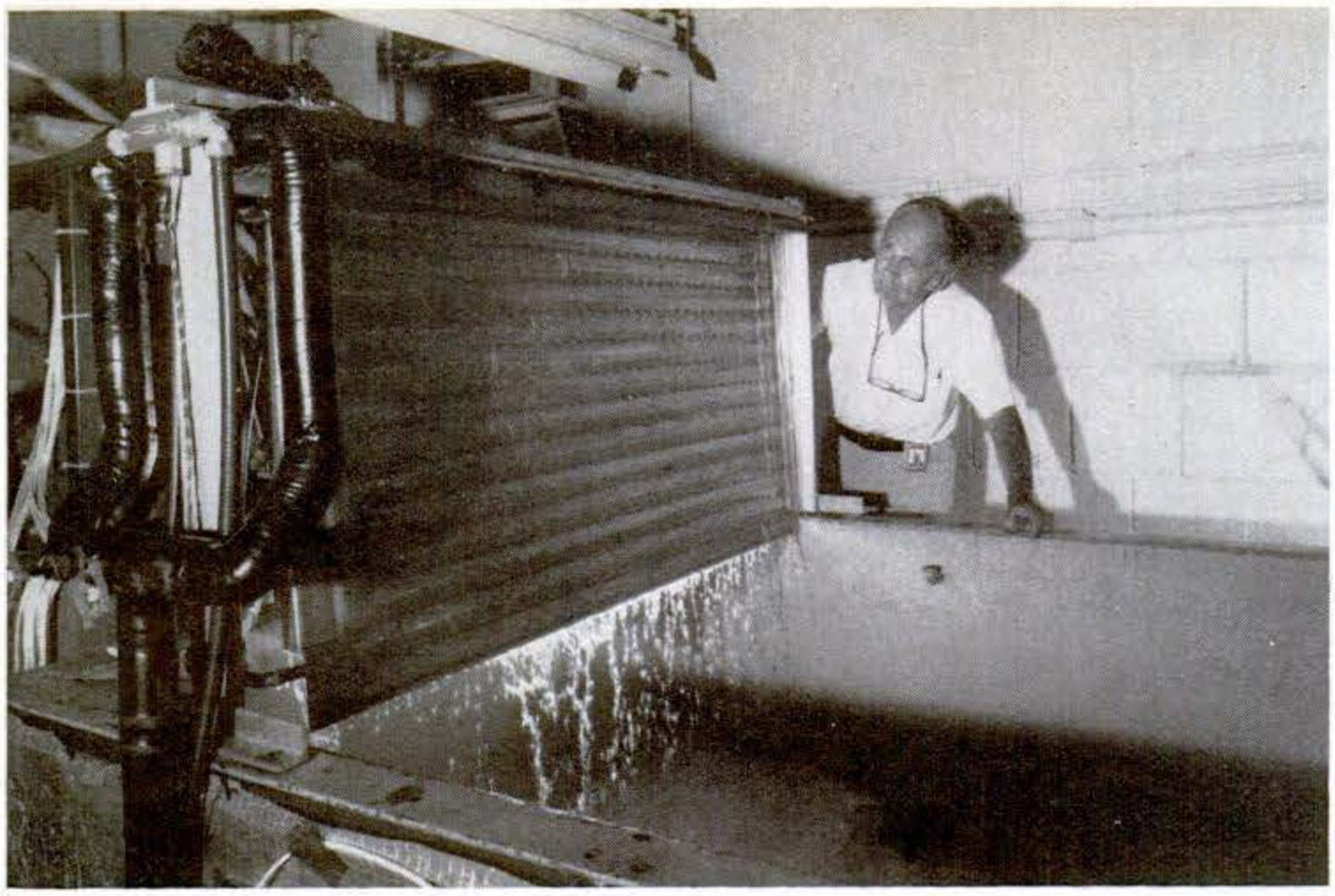

Next-generation ACES will probably use plate ice makers, similar to this laboratory model, instead of ice-making coils. Here, Harry Fischer, who originated ACES concept, watches as defrost cycle sends slushy ice into storage tank.

them only after he had publicized his idea. The heart of the system is a water-to-air heat pump, not terribly different from the air-to-air heat pumps many homes use [PS, Sept. '76].

The unusual element of an ACES is the large water tank (ideally, one to two cubic feet for every square foot of floor space in the house). At Homelab it's a heavily insulated concrete structure; it could be steel. Coiled within the tank are hundreds of feet of extruded-aluminum finned tubing. As you look out the large casement windows in the living room, the shiny foil that covers the insulation on top of the tank glints in the sun. In most installations the tank would be out of sight—either in the basement or under a patio or driveway. A. J. (Tony) Venturino, engineering specialist for the energy-conservation-and-utilization group at Westinghouse, uncovered a two-foot-square peek hole and showed me the ice cube: "The largest in captivity," he said proudly.

An ACES house works like this. In the summer, you simply pump a methanol-water solution through the tubes buried in the ice. The cooled liquid then flows through a heat exchanger in the air-circulation ducts. A fan blows air over the heat exchanger, cooling and dehumidifying the air, which circulates to cool the house. The cooling-cycle diagram, page 83, shows the flow.

The winter-heating cycle is a little more complicated. The heat pump extracts heat from the tank —even though it is at 32°F—and pumps it into the house to provide warmth. The diagrams show the process in detail.

It might seem that the most logical way to accommodate the seasons would be to let the temperature of the water tank fluctuate: Store up hot water all summer to use for winter heating, and store cold water in the winter for summer cooling. But that would take an enormous amount of water. A pound of water cooled one degree F yields one Btu of heat energy. For the millions of Btu needed for a season's heating or cooling, the tank would have to hold millions of pounds of water. But ACES relies on a phenomenon physicists call the latent heat of fusion—the energy change required to freeze or melt a substance. When you freeze a pound of water at 32°F, even though its temperature remains unchanged, you will extract 144 Btu of heat. When that ice melts, it gives up 144 Btu. Thus, if the storage tank in the ACES house is kept at 32°F, each pound of water can release or absorb 144 Btu as it changes state from solid to liquid, over and over again.

A standard air-to-air heat pump must take its heat from the outside air in winter, and there's not much there. Its coefficient of performance (COP—the ratio of heat energy delivered to the electrical energy required for operation) is likely to be about two. But because an ACES heat pump operates at essentially constant conditions, does not have to reverse itself for defrosting, and does not have a power-consuming outside fan, its COP jumps up to about three in the heating mode. A conventional heat pump must run as an air conditioner all summer (at a COP of about 2.5); with an ACES, the heat pump won't be needed in the summer, as long as the ice lasts. The efficient winter operation, coupled with essentially free summer cooling, boosts the combined coefficient of performance for this system to a whopping five. And you can get domestic hot water from the system as well.

Climatic range

The ideal climate for an ACES in a well-insulated building is 36° north latitude—a line running approximately through Greensboro, N. C.; Nashville, Tenn.; and Oklahoma City. There, the ice formed in the winter should just about run out as the summer fades into fall. North of that ideal climate, solar collectors can be used to send heat to the storage tank to melt some of the ice. Thus you increase the heating capability without creating an ice cube larger than you need for the summer (see melt-back diagram, page 83). In more southerly areas, the insulation around the tank would be beefed up, but even then the ice probably wouldn't last all summer, so you'd run the compressor at night to make ice in off-peak hours. And the heat not needed for domestic hot water would be rejected through a radiator.

Such adjustment techniques can also be used anywhere the storage tank isn't large enough to accommodate either season. "I think there needs to be some kind of heat-pick-up-and-rejection system in just about any ACES installation," says John Moyers. "There are variations in climate and lifestyle from year to year that you just can't design for."

Homelab, with a 1600-cubic-foot tank and 1800 square feet of floor space, uses both techniques: solar assist and summer-heat rejection. A single device serves both needs. I first saw one of these collector/radiators as I walked up the driveway of Homelab, with Tony Venturino, a tall, friendly man who spends his leisure hours doing portraiture and landscapes. On the roof of the house was a black rectangular box—obviously some kind of solar collector. But it had no glazing. "Where's the lid?" I asked Tony. "There isn't any," he replied.

The 40-by-seven-foot device is simply extruded-aluminum finned tubing exactly like the coils in the storage tank, but painted black. Tubes are ½inch in diameter and

[Continued on page 152]

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Here at last– video-disc players

Two disc machines that let you program your own shows will be introduced in '77

By JOHN FREE

Sometime this year, TV viewers in selected areas of the country should be able to schedule their own shows in an entirely new way. They'll select movies, musical performances, or other material on video discs, slip the discs into players wired to their receiver's antenna terminals, and push a button to watch the show.

A long list of glittering new video players has been promised, postponed, or introduced in recent years, only to fade from sight. But there are definite signs that at least two major worldwide organizations with the financial muscle and marketing know-how to succeed will begin selling their video-disc players regionally in 1977.

One of them, RCA, is already field-testing a few hundred of its capacitance-sensing SelectaVision disc players. N.V. Philips, the Dutch firm that brought us the standard audio cassette, and MCA Inc., an American entertainment-oriented firm, also plan to offer an optical video-disc system this year.

The latest price estimates: about $500 for the player, and $10 to $18 for a disc or set of discs.

There's even a possibility that a Japanese licensee of a British and German disc venture, the grooved-disc TED system [PS, Nov. '74], could be marketing disc players, too. Players for 10-minute TED discs have been available in Germany since 1975, although only for European TV-signal standards. Sales have been poor. A TED changer that handles 12 discs was recently shown. Spinning on the sidelines are other disc systems still under development [see box: "In the labs: machines that record and play discs"].

A technician slides a SelectaVision video-disc player into its outer cover at RCA's new plant in Indianapolis.

Both the RCA and Philips/MCA players will appear in stores just when new home video-cassette recorders [PS, Dec. '75], video games [PS, Nov. '76], and pay-cable programming are teaching viewers that their TV receivers can easily display something other than fixed-time broadcast fare.

What's different about the new disc hardware and programming? After operating both the RCA and Philips/MCA players, trying some amazing manipulations of TV images, and listening to stereo hi-fi TV sound I found that the new machines offer spectacular gains in performance compared with other home program sources.

Stamping out tons of discs at low cost is the biggest advantage of the new medium. Both Philips/MCA and RCA expect to offer a broad selection of discs when their players appear. MCA, which will manufacture most U.S. discs for the Mag-

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navox-built player, plans 1000 albums initially.

MCA discs will include new and old films, ballet, opera, theater, sports, how-to and children's programs, and documentaries. MCA can also make a thin flexible disc that might be inserted in periodicals. Discs may also be distributed as entire magazines, catalogs, or talking encyclopedias.

Also, a variety of independent companies will add other special-interest discs to catalogs. One firm, Visiondisc Corp. of New York, for example, planned to tape last year's Christmas services and works of art at a large cathedral for transfer to discs.

Here's how the two leading players and disc formats differ:

RCA's SelectaVision

This machine is designed to play a rigid, grooved disc 12 inches in diameter and programmed on both sides with 30 minutes of material. The function of the spiral groove is to guide a stylus, much as in an audio-disc system.

But that's the end of any similarity to familiar 33-1/3- or 45-rpm discs. The SelectaVision player, which won't operate unless the lid is closed, spins discs at 450 rpm. TV signals are encoded as minute rectangular depressions at the bottom of each groove. The slots vary in spacing and width, with some as narrow as 0.25 microns (millionths of a meter). RCA devised a method of producing the slots on a disc master, using a sharply focused electron beam, since required widths are too narrow to be generated optically with light. The discs have a vinyl base topped with thin layers of metal, an insulating plastic (dielectric), and an oil lubricant that reduces stylus wear.

Together, the disc and metal-tipped stylus form an electrical circuit. As the slots spin past the stylus, tiny abrupt changes in circuit capacitance occur. These changes detune an oscillator circuit to produce the TV signal.

To compensate for small changes in rotational speed, a tiny transducer, which functions somewhat like a loudspeaker coil and cone, stretches the stylus arm back and forth parallel to the groove. Errors in speed are detected by monitoring the recorded color-burst signal.

A close look at a SelectaVision player confirms RCA's disc-system-design philosphy. Components are housed in a simple, inexpensive cabinet with a minimum number of controls. Internal circuit boards and components, prominently displayed on a pegboard in RCA's New York demonstration room, remind you of a Heathkit spread out for assembly. RCA deliberately designed a player that could be easily mass-produced with relatively standard parts.

Care is necessary when loading discs in the machine, since fingerprints or smudges can create interference. Playing discs repeatedly through can remove contaminants from the grooves, but since the $15 stylus must be replaced after 200 to 300 hours of use, it's wiser to take good care of records. Each disc can be played about 500 times.

Pictures I've seen at several demonstrations were excellent. You can rapidly move the tangential stylus arm forward or backward to selected disc areas by pushing buttons; a lighted index on the panel becomes larger or smaller. A pause button breaks stylus contact. The player has two audio channels for stereo or bilingual programming, and audio output jacks for optional connection to a hi-fi amplifier.

Philips/MCA player

This concept differs radically from SelectaVision. Only the center spindle touches Philips/MCA discs as they spin at 1800 rpm. An air bearing that develops at that speed aids stabilization. A low-power laser

[Continued on page 140]

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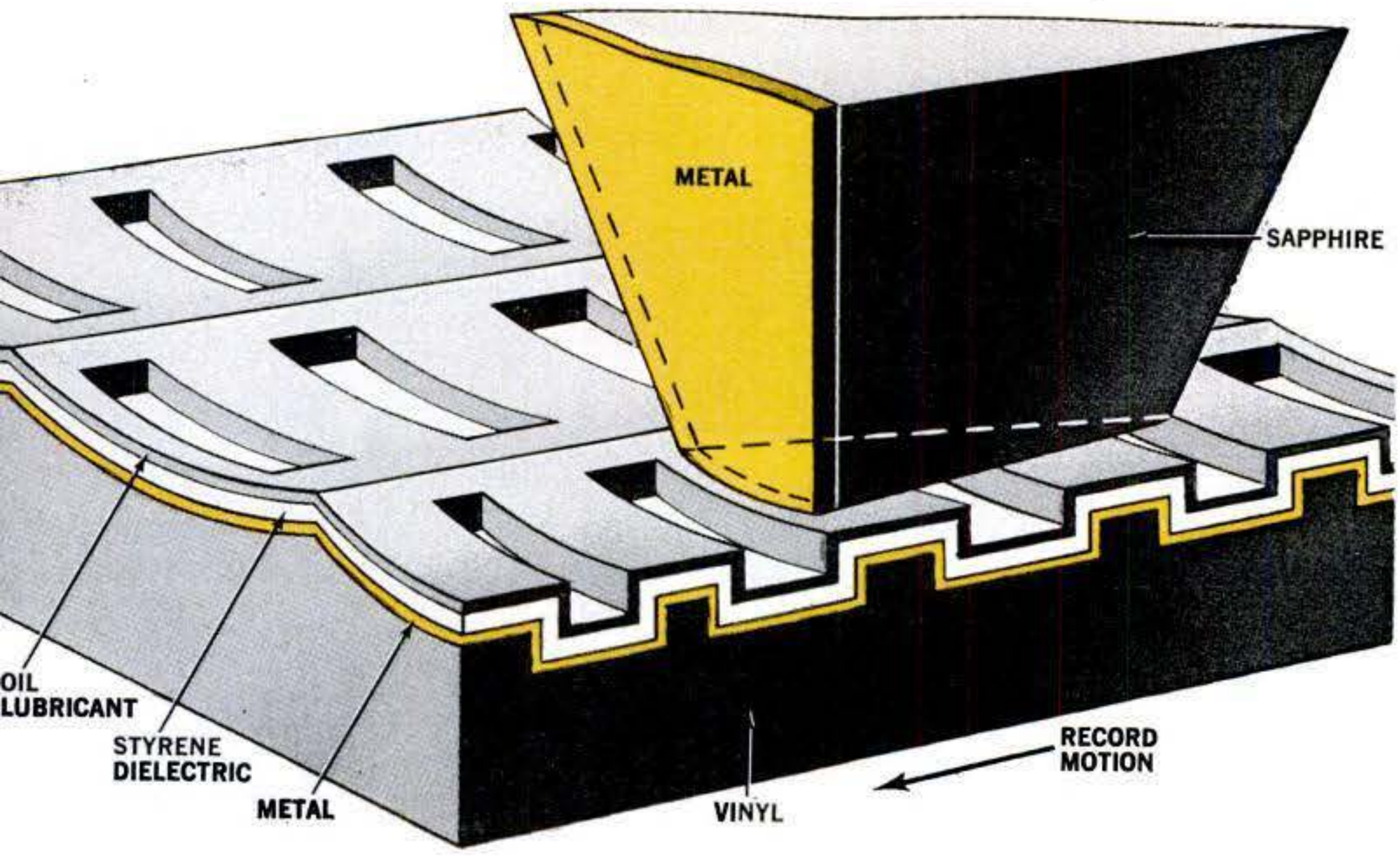
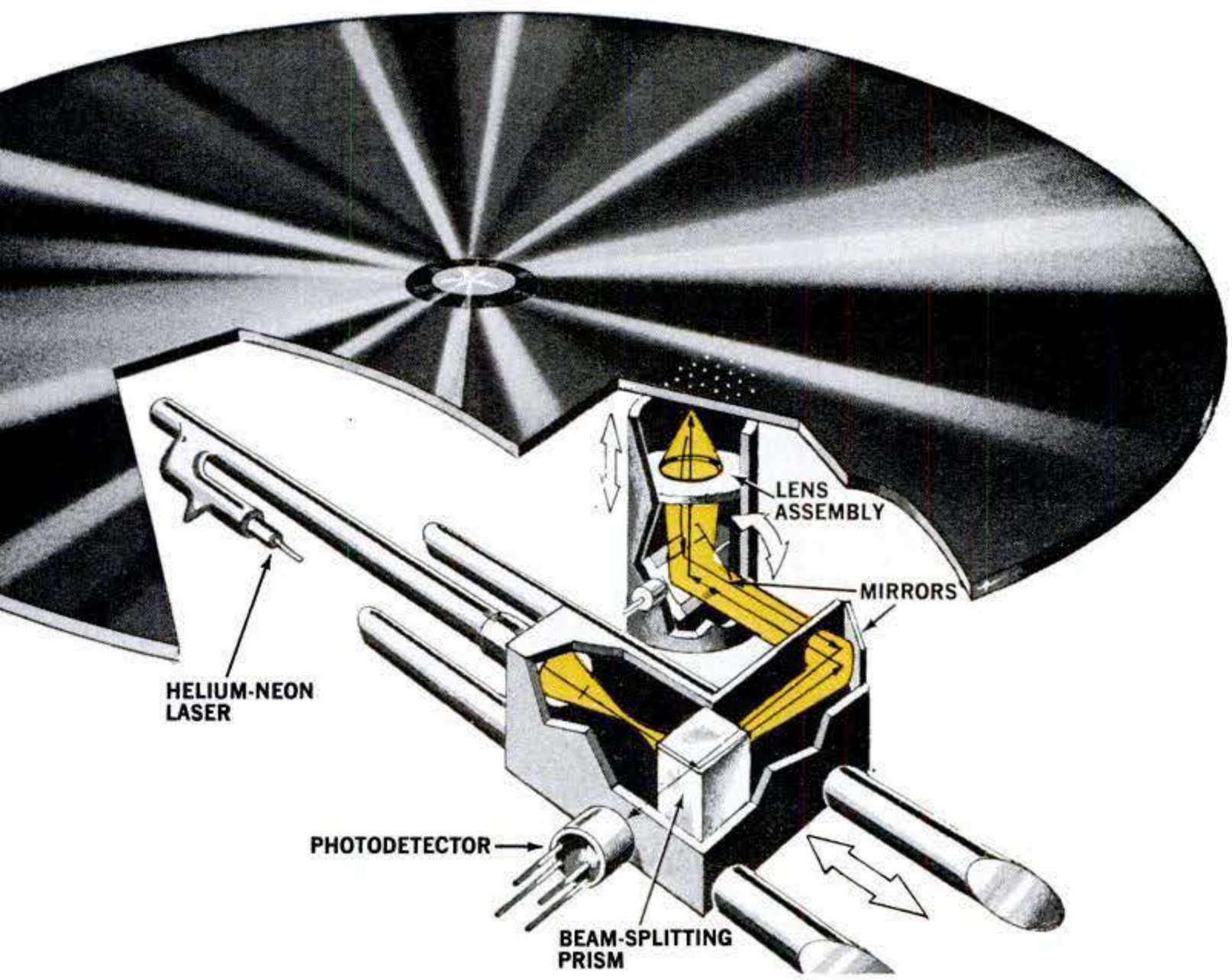


A stylus that detects picture signals in grooves

RCA SelectaVision player (far left) spins rigid 0.07-inch-thick discs at 450 rpm. Discs carry 30 minutes of material on each side. TV signals are detected by a metal-tipped sapphire stylus tracking at about 50 milligrams in a spiral groove. Picture information is recorded on discs as microscopic slots of different width and separation. The metallic stylus senses a change of electrical capacitance as the slots spin beneath it. This capacitance variation changes an electronic signal that is unscrambled into TV pictures. Metallic and dielectric coatings necessary for playback give SelectaVision discs a shiny appearance. There are 5555 grooves per inch, and each circular groove stores four 1/30-second TV frames. The player has fast-forward and reverse buttons for cueing.



Laser-beam system decodes a spiral track of bumps

Philips/MCA optical video-disc player (far left), manufactured by Magnavox, rotates discs at 1800 rpm. Players can handle either rigid 0.04-inch-thick discs, or, with an adapter, 0.007-inch flexible versions. Nothing contacts the disc for picture readout: A laser beam is focused through a mirror/lens system onto a spiral track of bumps on the bottom of the disc. Spacing between the bumps varies according to TV picture information. The bumps scatter the beam, but the flat, shiny aluminum area between them reflects light back through a two-way prism or mirror to a photodiode detector. The detector circuits convert the code-like flashes from the disc into a TV signal. Tracks are less than two microns (millionths of a meter) apart. The player can endlessly freeze a TV frame, show fast or slow-motion pictures, and display on the screen the number of up to 54,000 separate coded frames. Discs hold 30 minutes of programming on one side only.

In the labs: machines that record and play discs

As the big contenders (RCA, N.V. Philips, and MCA, Inc.), gear up production lines to produce capacitance and optical video-disc systems (diagrams above), other companies and institutions are busy refining other ingenious disc systems in laboratories. Although developers of new players frequently say they plan to market them, the huge expense of manufacturing and distributing a major new product today may prevent you from ever seeing most new systems in stores. Some of these disc systems are intriguing because they can record TV programs as well as play prerecorded discs:

- A magnetic disc recorder (MDR) has been under development for several years by Erich Rabe, a German record manufacturer [PS, Nov. '74]. The latest version, demonstrated last year in Europe, presented poor color pictures. Meanwhile, a U.S. licensee, TV Disc Corp. in Waltham, Mass., is developing its version of MDR. The Rabe recorder/player, similar in appearance to an audio turntable, has a tone-arm-mounted recording head that rides in the grooves of the magnetic disc. The head can record 24 tracks in the groove walls, and might provide two-hour discs. Early 12-inch discs of this type played at a slow 156 rpm.
- Another disc-recorder system, developed by University of Toronto professor John Locke and a graduate student, encodes TV signals onto a specially formulated plastic with a low-power laser beam. Locke told the trade weekly, *Television Digest*, that he expects a home video-disc recorder would use a dual-power laser. The higher-power beam—perhaps only two milliwatts, or twice that of the Philips/MCA readout laser—would record, and the low-power beam would play back. Locke says he is in touch with potential manufacturers.
- In Japan, Hitachi Ltd. has developed a holographic video disc (playback only) that eliminates the complex focusing and tracking devices used in other optical systems. (Holograms are photographic images made with laser light.) The disc system, described in the June,1976, *Applied Optics*, employs a continuous train of one-millimeter-square holograms on the disc's surface. Each hologram is actually three separate images (for brightness, color, and sound) offset 120° from each other. The disc rotates at only six rpm.

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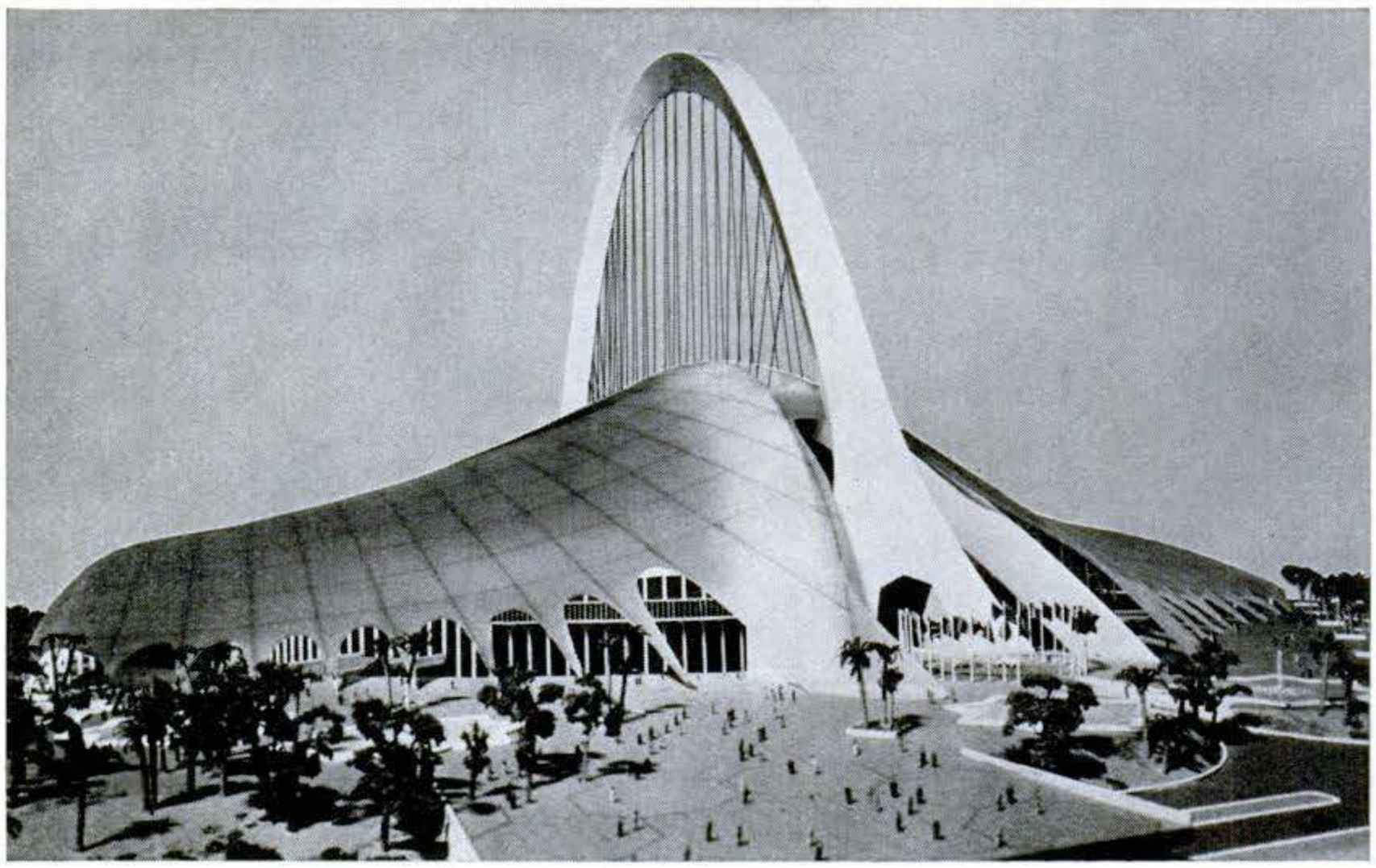
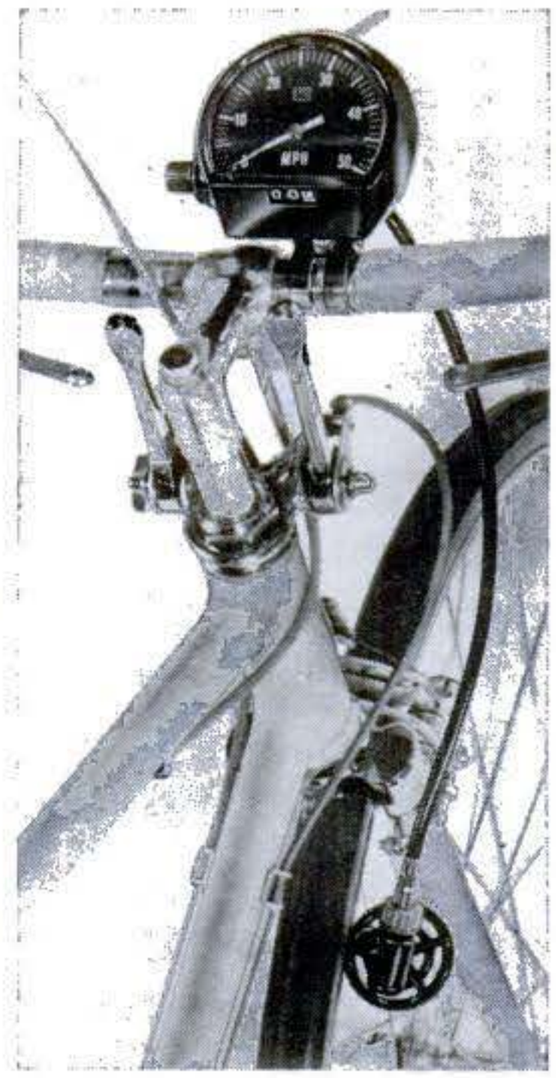
What's New

A PICTURE ROUNDUP OF NEW PRODUCTS AND DEVELOPMENTS



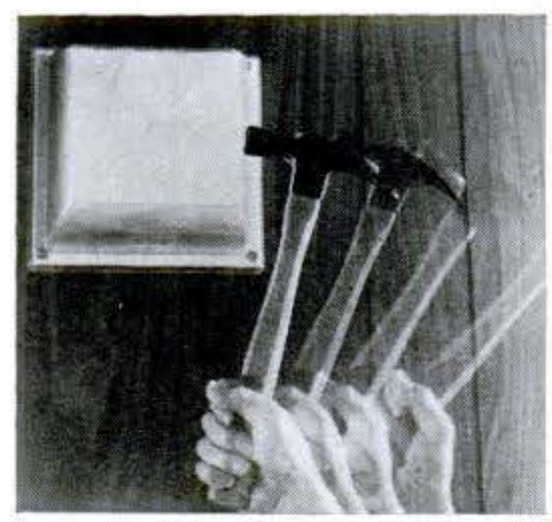
80,000-seat Saudi stadium

A giant arch will loom 716 feet over the massive, Olympic-size stadium planned for Riyadh, Saudi Arabia. The hollow arch is made from a tubular-steel lattice clad in glass-reinforced polyester. It supports a near-opaque, polyester-covered, cable-net roof. Louvered center panels will let air and sunlight reach the grass playing field. Designed by a team of British architects, the $350-million stadium will have a 200-seat restaurant at the apex of the arch, reached by a train running up inside the leg.



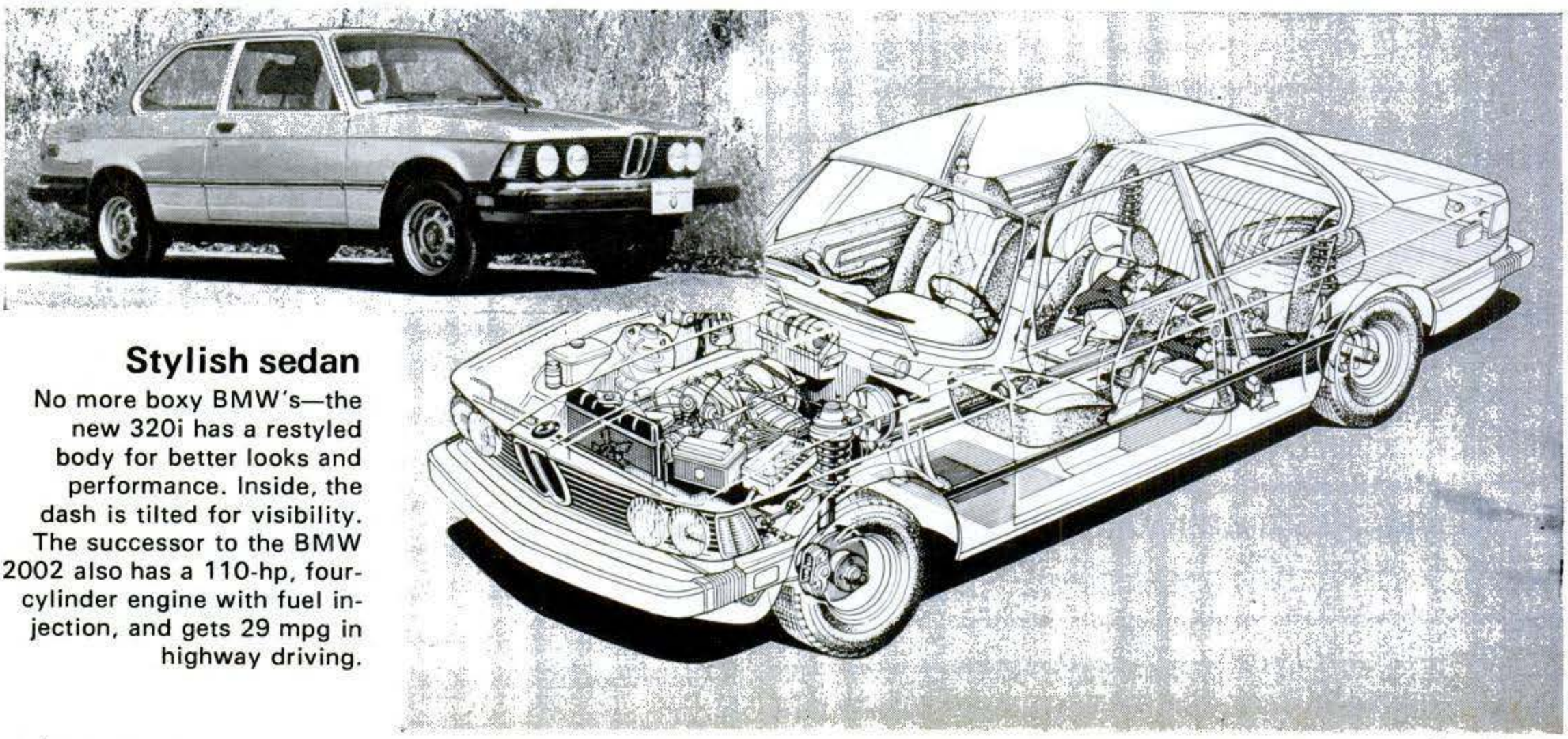
Mile counter

A new tire-driven device from Stewart-Warner records cycling speed and distance. It mounts on the fork instead of the wheel hub—great for bikes with quick-release wheels. A spring presses it against the tire. Price: $14.95.



Vandalproof light

Hammer-wielding vandals can't disable this emergency lighting unit. A Lexan plastic cover shields mounting screws and hardware. Pounding won't harm either the light or batteries, says the maker, Tork, Inc., 1 Grove St., Mt. Vernon, N.Y. 10550.



Stylish sedan

No more boxy BMW's—the new 320i has a restyled body for better looks and performance. Inside, the dash is tilted for visibility. The successor to the BMW 2002 also has a 110-hp, four-cylinder engine with fuel injection, and gets 29 mpg in highway driving.

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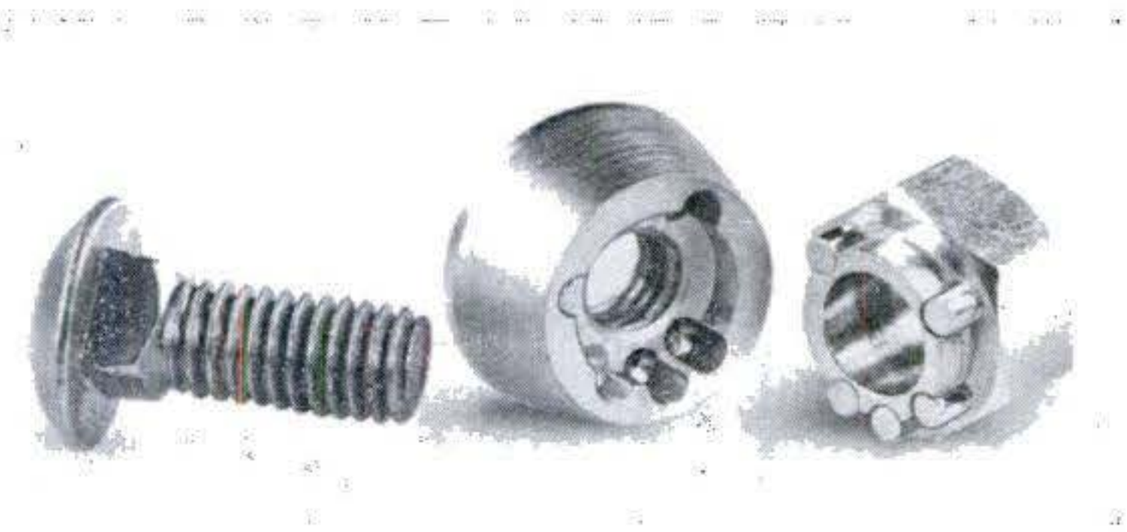
Advanced-design T-tail trainer

The novel T-tail on this Beech Aircraft's new Model 77 trainer is usually found only on high-speed jets. The high tail gives better landing control, says Beech, since it keeps the elevator in the calm air above the prop's slipstream. The GAW-1 wing is an outgrowth of NASA's supercritical-wing-technology research [PS, Apr. '75]. It increases lift and reduces drag so the plane can fly faster and farther using the same power. The two-seater, planned for delivery next year, has a four-cylinder, 115-hp Lycoming engine.

Sporty coupe

A five-speed overdrive transmission is the new option on Datsun's '77 version of the 280-Z. Other new features: hood louvers and restyled bumpers. The engine is a 170-hp overhead-cam six, with electronic fuel injection. The car gets 21 mpg, costs about $7165.



Locking nut

A new lock for bolt-down valuables should discourage thieves. Only Superlock's keyed torque nut can twist off the tapered lock nut, says the maker (Superwinch, Box 338, Glastonbury, Conn. 06033). It comes in many sizes and combinations. Price: $5.95.

Portable sun lamp

You can get a tan anywhere in the house with Sylvania's sun-lamp kit. It has a 275-watt lamp, timer, and a base that can be wall-mounted or hooked over a chair. Safety feature: The timer must be reset after 10 minutes. About $35.

Safety harness

The "Little Rider" attaches in seconds to auto seat belts, says Rose Mfg., (Englewood, Colo.). The force-distributing design is based on harnesses worn by racing pros. It's for kids 15-50 lb., of sitting age. $11.95 at Sears.

Hiking machine

"Walking" across streams and up hills, the Swedish X-Mouse swings its wheels to clamber over obstacles. Pivoting arms have separate hydraulic motors, fed by pumps driven by a 65-hp engine. The combat vehicle does only 31 mph, but can hide in underbrush.

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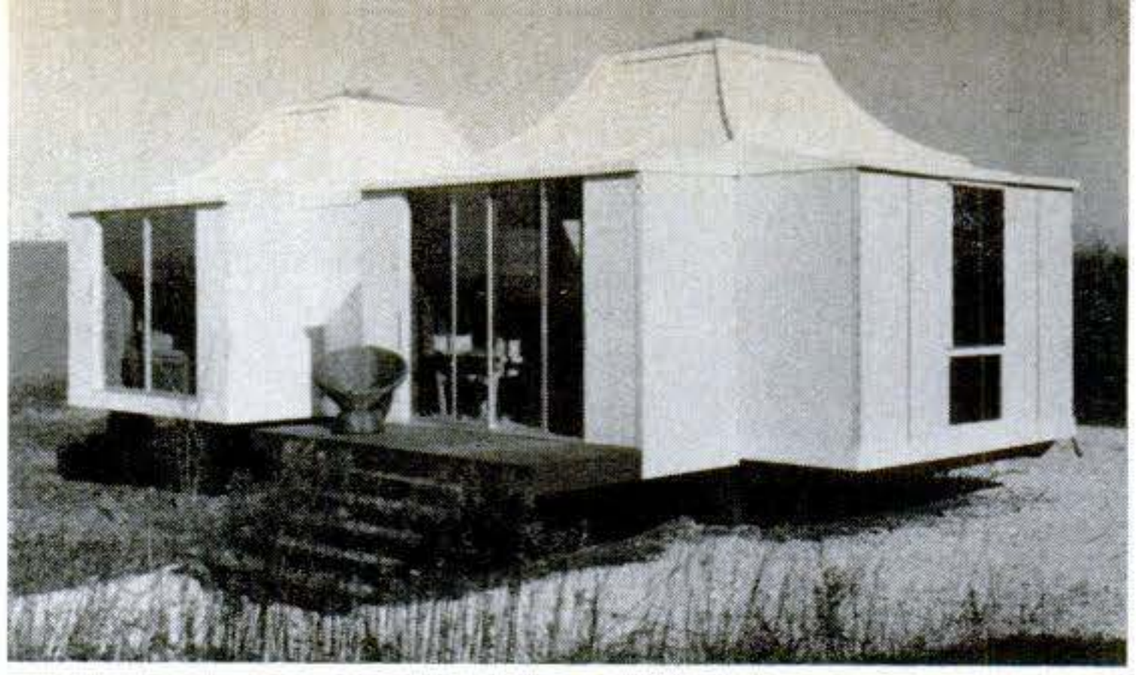
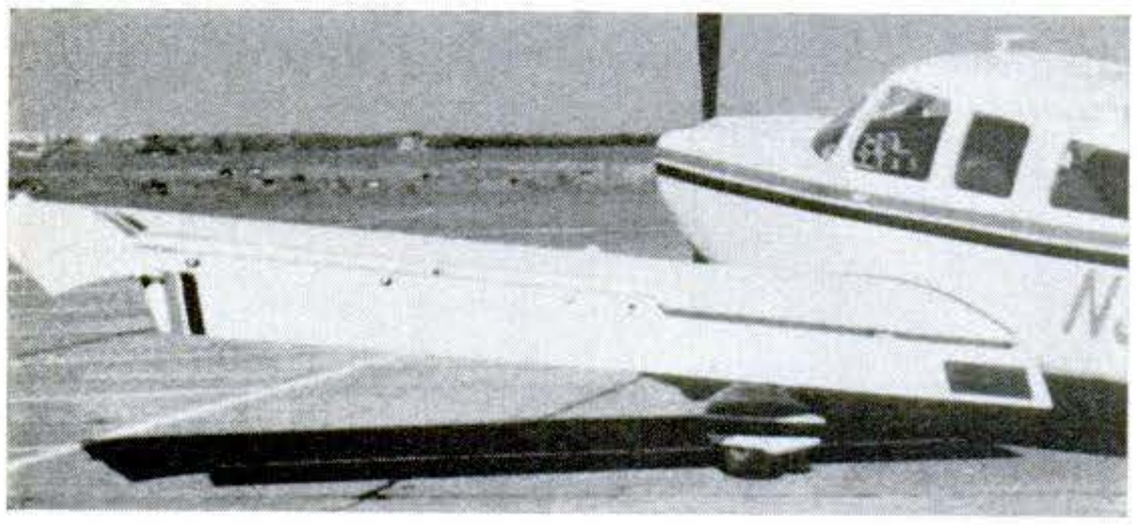
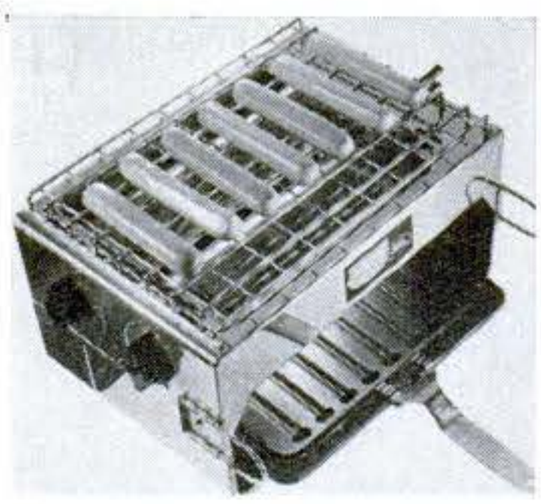
What's New



Modular house

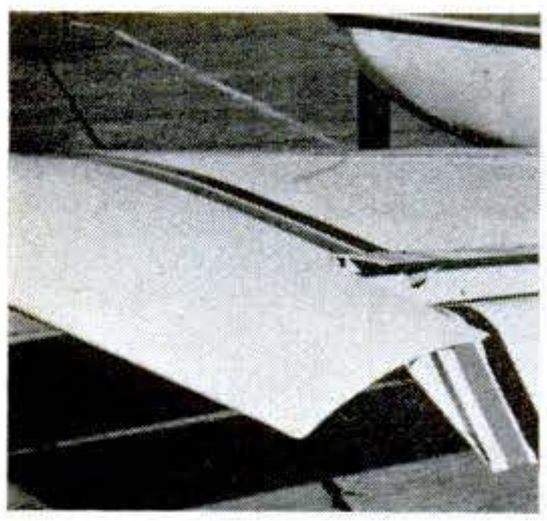
You never paint this fiberglass modular structure; it's designed to be maintenance free, inside and out. It has no wood. The 24-by-24-foot unit has 423 square feet of floor space. International Modular Structures, Box 318, Bala Cynwyd, Pa. 19004. Price: $4500.





Camper's broiler

You can cook and heat with the Small Wonder LP-gas infrared device. It has two burners that allow you to cook and grill when they're up, or broil and toast when they're down. It's made by Detroit Radiant Products Co., 1297 Terminal Ave., Detroit, Mich. 48214. Price: $89.



Plane controls

Improved flight safety for small planes is achieved with wing spoilers instead of ailerons on the wing tops, claims Robertson Aircraft Corp., Renton, Wash. The new spoiler permits longer flaps—for more lift for shorter take-offs and landings, and reduced accidents.

Anti-theft lock

A new steering-wheel lock won't let thieves sit in the driver's seat when it's pointed down. The 22-ounce Auto Gard can't slip when it's locked on wheel, and can only be released with a key. It's made by Freeline Ltd., 11 Brook Gate, South Liberty La., Bristol BS3 2UN, England.

Auto skates

Tight parking spots faze you? These new car skates let you position a vehicle so you can drive away easily. The skates can be used to swing a car 180 degrees. Made by Patented Products & Co., 31 St. Bernards Rd., Olton, Solihull, West Midlands B92 7AU, England.

Hybrid car

A 400cc gas engine drives a 3½-kw generator on this British prototype and keeps its batteries on steady charge as current is used to drive the car's eight-hp motor. The 550-pound car has a laminated glass roof and gullwing doors. William Towns, designer of the Aston Martin Lagonda, also designed this.

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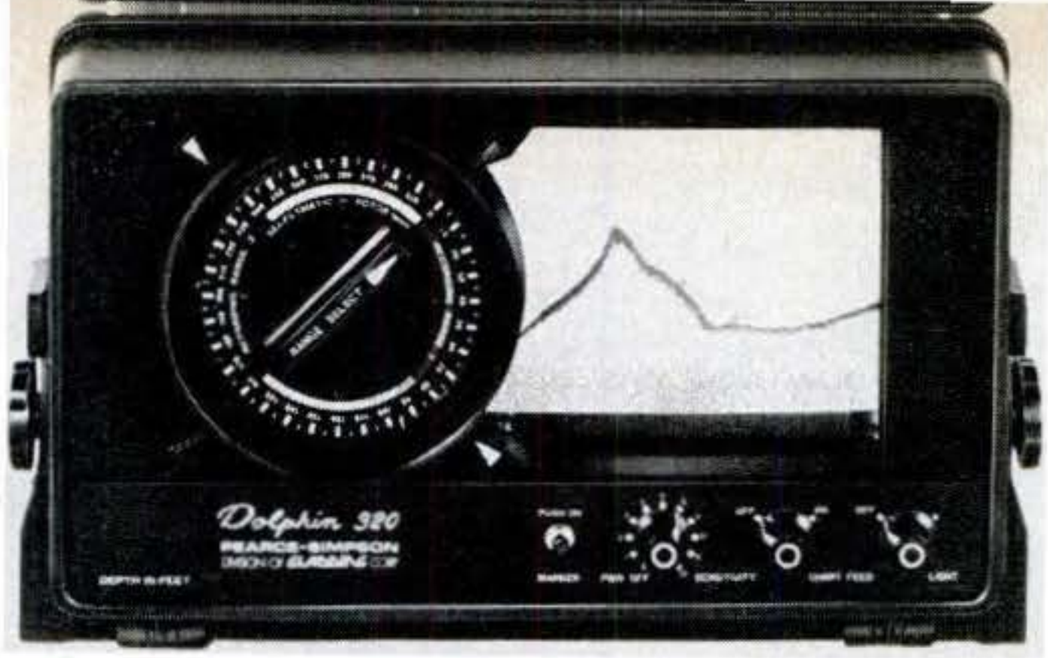
What's New
IN BOATING

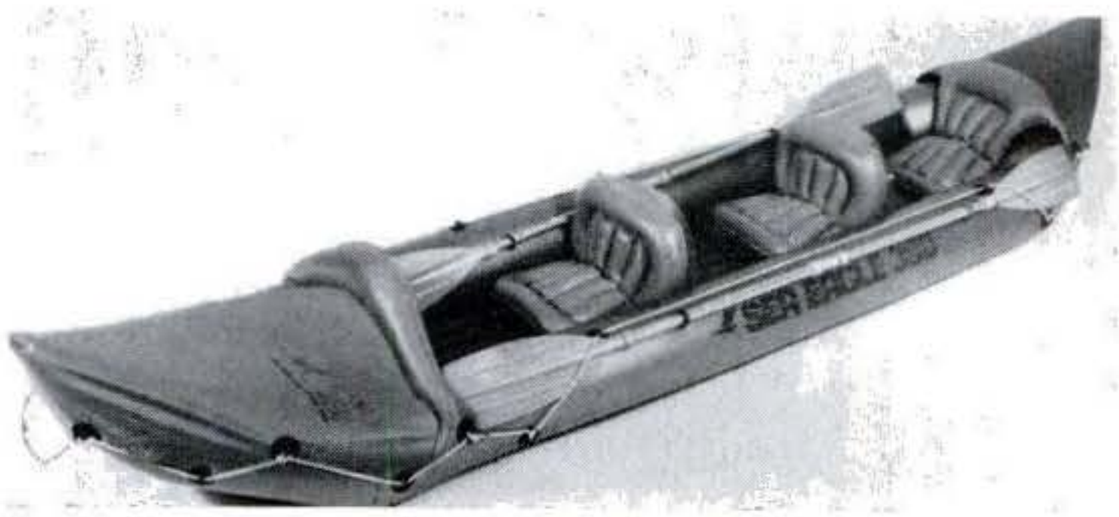


Fishfinder
The Dolphin 320's powerful transmitter enables it to give printouts of the bottom to depths of over 350 feet. The four-inch chart is calibrated in four scales of 80 feet each. Maker: Pearce-Simpson, Box 520800, Miami, Fla. 33152.

Mini hatch
Need more air below deck? The 130 hatch can be used on boats of all sizes. The frame is made of aluminum; the cover is Lexan. Deck opening is 10 by 10 inches. It sells for $100. Maker: Bomar, Inc., Box 162, 1021 Post Rd. E., Westport, Conn. 06880.

RDF plus
Vecta's versatile hand-held radio direction finder is also a hailer, fog siren, and listening device. It has a plug-in module pretuned to a specific radio-beacon frequency. V/T Sales Corp. (1331 South Dixie Hwy., W. Pompano Beach, Fla. 33060) sells it for $275.

Easy tilt
Olson's motor lift gives you extra muscle when you tilt outboards by the top of the shroud—especially helpful for motors weighing 150 to 300 pounds. It's made by Olson Industries, Box 2520, Sarasota, Fla. 33578. Price: $19.43.



Blow-up canoe
Two adults plus gear for several days of camping can fit in this inflatable canoe. The Sea Eagle 380 is 12'6" long, weighs 36 lb., has a double bottom to protect it in white water, plus two sealed side hull compartments. It's $260. Leisure Imports, 104 Arlington St., St. James, N.Y.

Lunker hunter
Lightweight MFG Super Bass 14 is ideal for inland-lake fishing. It's easy to tow, weighs 550 lb. The 14-footer has two folding fishing chairs, a captain's chair, a live well, and glove box. Made by MFG Boat Co., 55 Fourth Ave., Union City, Pa. 16438. Price is $1629.

Boatman's radio
Want to hear everything on the air while on the waves? The AM/FM/LW/SW 32-band Sony CRF-320 makes it possible. It has an LED digital display frequency, plus a frequency synthesizer and dual conversion circuit to stabilize shortwave reception. Price: $1600.

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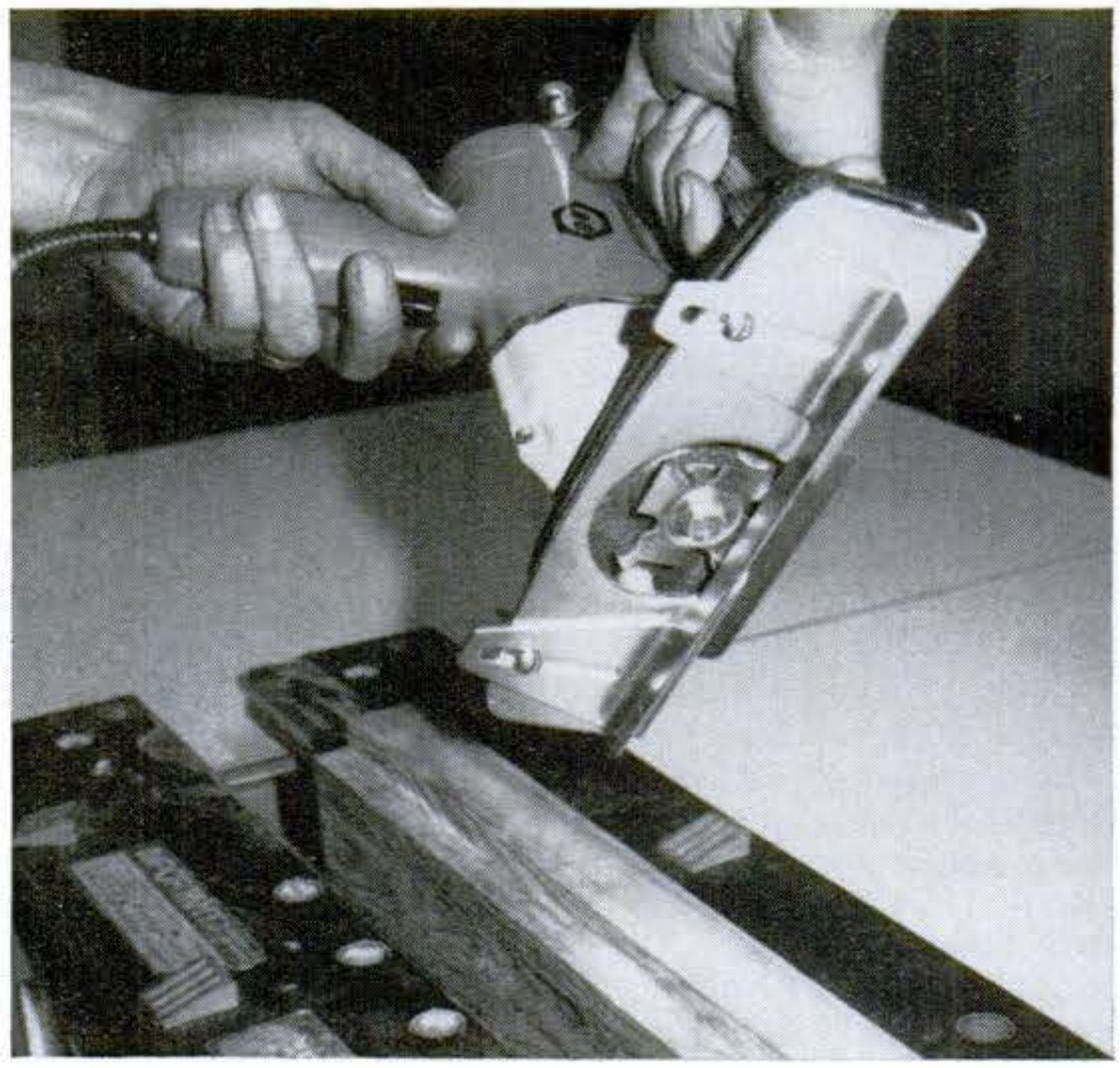
What's New IN TOOLS

BY R. L. STEPLER



Power plane

Remove your drill's chuck and screw on Rotor Plane: Now you can skim rough floors, smooth ragged timber, trim sticking doors. Depth gauge controls the cut. Made in Britain, Rotor Plane sells there for about $26. Farnworth Engineering, Gower St., Farnworth, Bolton, Lancashire, England.

Chain saw

Need power and bar to get through big logs and trees? Kioritz claims its model CS-351VL provides it, with a 14" or 16" bar and 35cc engine. It weighs 10.13 lb., uses a 20:1 fuel/oil mix. Price: $189.95. Kioritz, 350 Wainwright, Northbrook, Ill. 60062.

Hot torch

The OX5000 torch can cut up to 1/4" steel plate and 3/4" bolts, the maker says. The hand-held unit combines oxygen with propane or Mapp gas. The kit costs $39.95, includes regulator assembly, oxygen cylinder, goggles, lighter. Bernzomatic, Rochester, N.Y. 14613.

Files

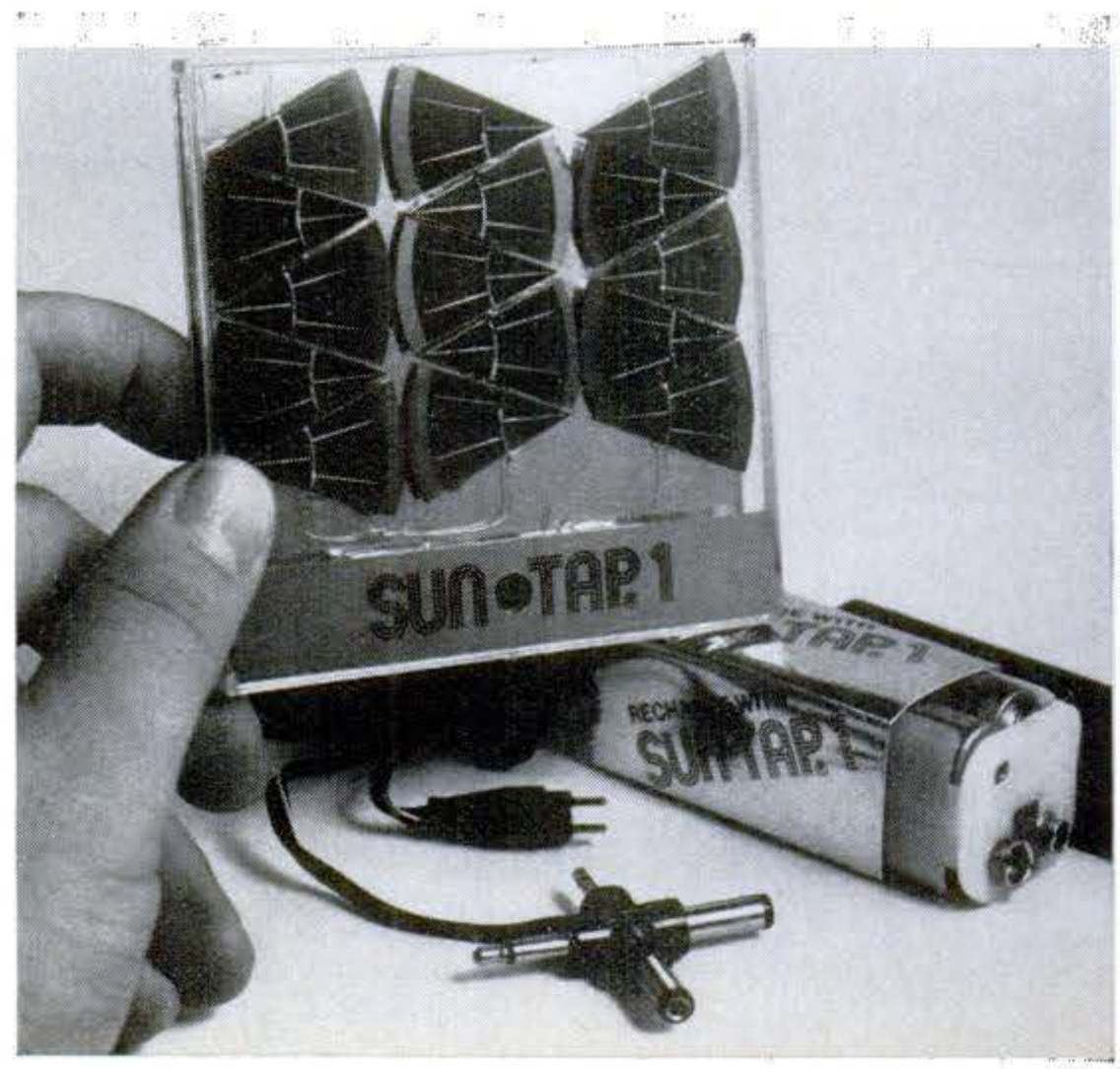
Plasti-Cut files are extra hard and sharp for fast, smooth finishes on laminates, plastic, fiberglass, and metals. A 10" mill file costs $2.50; a 10" flat file is $4.25. Other lengths are available. From Practical Products, 7820 Concord Hills Lane, Cincinnati 45243.

Power polisher

This new double-insulated scrubber-sander-polisher from Ward's prevents burns, streaks, and swirl marks. Velcro tabs grip sanding disks, polishing bonnets. The price, under $50, includes case, three disks, three bonnets, and other useful accessories.

Solar charger

Give Sun Tap 1 its spot in the sun and you can recharge four AA Nicad batteries, or power radios and calculators directly from sunshine. Price, including four batteries and four-way recharging plug, is $41.95. Sun Tap, Inc., P.O. Box 754, Arlington Heights, Ill. 60006.



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What's New IN HOME IMPROVEMENT

BY R. L. STEPLER

Solar controller

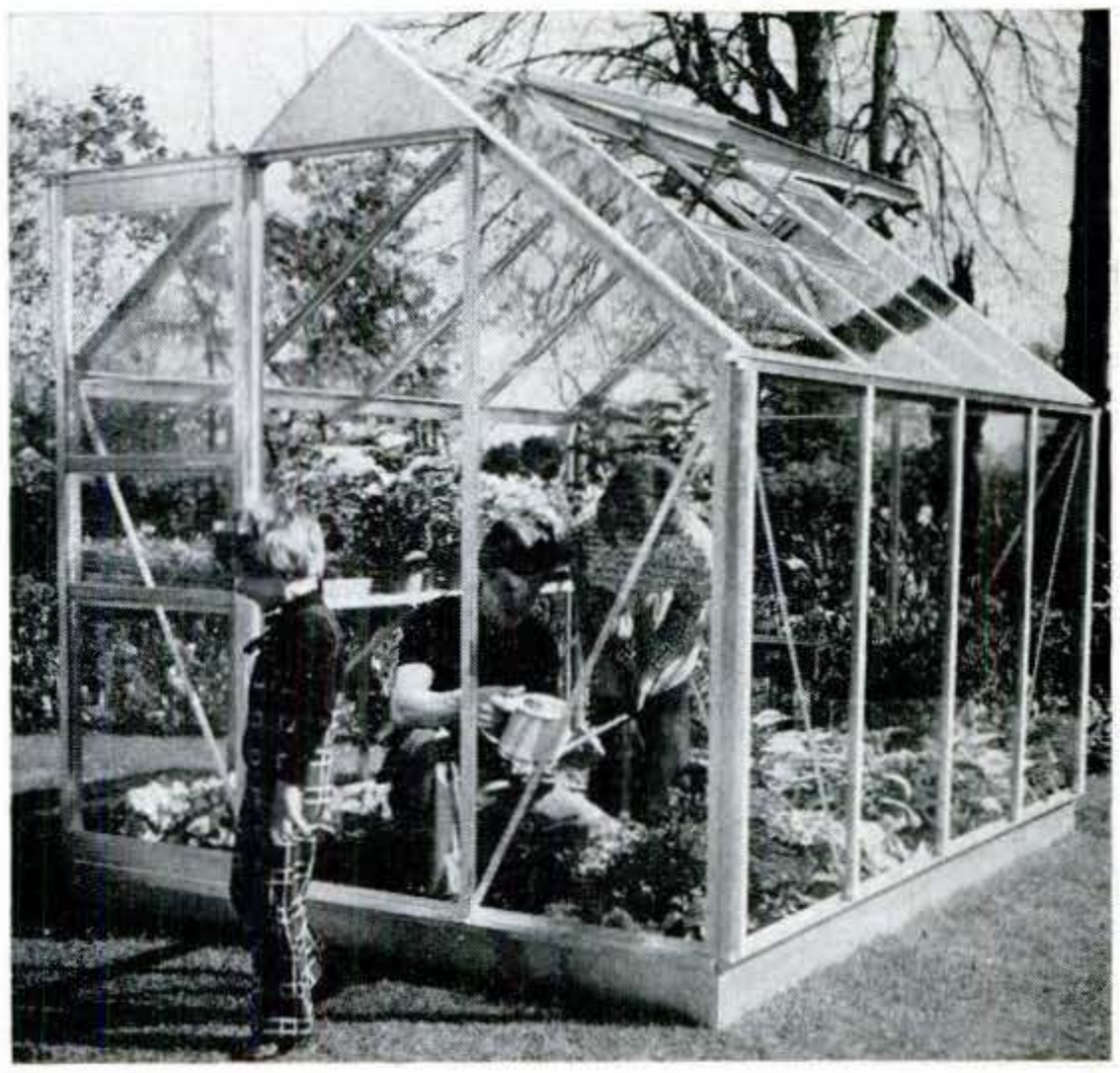
Amsolheat differential thermostat has two thermistors—one inside the collector and one outside to measure ambient temperature—to assure that a drain-down solar system won't freeze up. Model 1100 sells for $135. American Solar Heat Corp., 7 National Pl., Danbury, Conn.

Radiant heat

If you guessed that the framed landscape on the wall is the radiant-heat source for this room, you're right. The 36" by 22" by 1" panel uses 570 watts, heats a 10- by 15-foot area. Its surface—tiny silicon crystals—stays under 200°F; it won't burn fingers, ignite cloth, or scorch walls. Price: $79.95. Maker: Aztec, 181 E. 56th Ave., Denver, Colo. 80216.

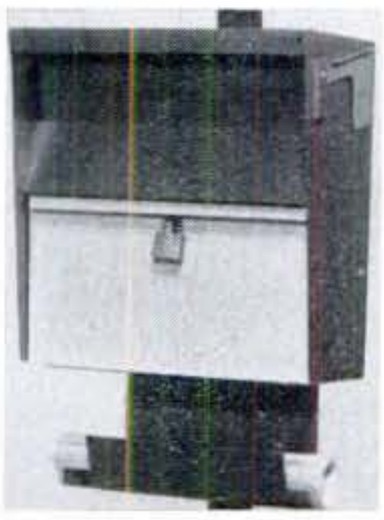
Heat pump

It looks like a standard through-the-wall electric resistant heating/air conditioning unit. But it's a heat pump. G.E.'s new Zoneline III units operate as reverse-cycle heat pumps down to 35°F, then switch to resistance heating. Three models are offered: 9000, 12,000, and 14,000 Btuh. Cooling-mode EER's from 6.8 to 7.5 describe the energy savings. General Electric, Appliance Park 6-106, Louisville, Ky. 40225.



Do-it-yourself greenhouse

Illustrated, step-by-step instructions help you assemble the Edward Owen safety greenhouse in a weekend, according to its maker. Features: aluminum frame inside, plastic insulating strip outside to conserve heat; tempered safety glass; integral gutters and downspouts to let you collect rainwater. Four models offered: 8'5" by 6'5" ($695); 8'5" by 8'6½" ($795); 8'5" by 10'6" ($895); and 8'5" by 12'6½" ($995). All are 7'11" to ridge, include sliding door, roof vents. Mak Edward Owen Engineering, Snow Shoe, Pa. 16874.

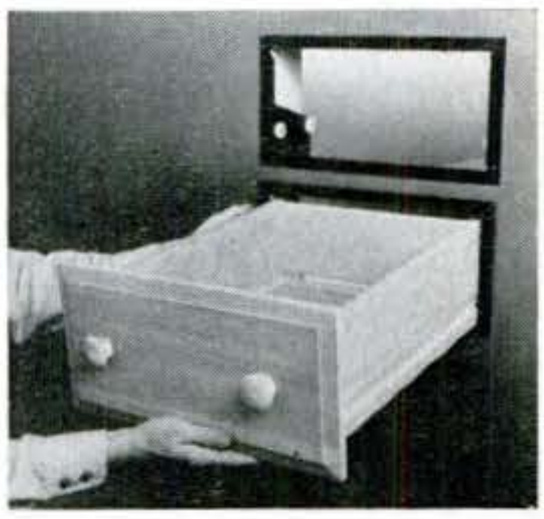


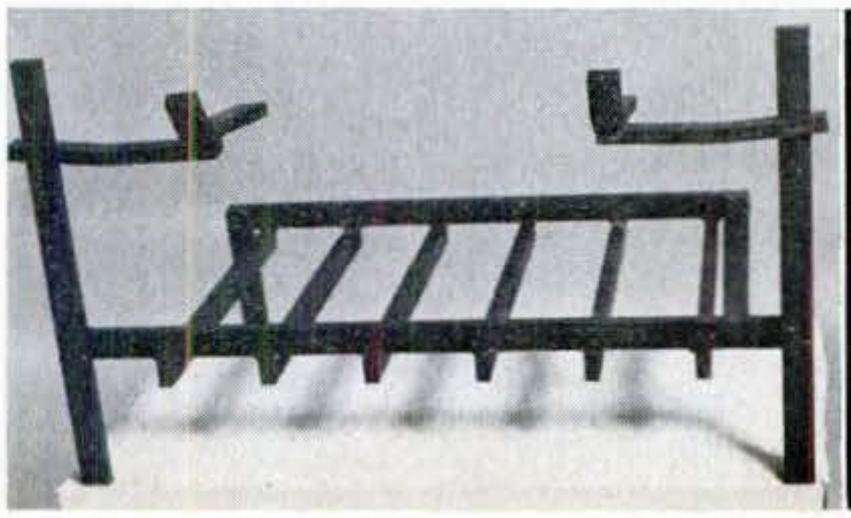
Mailbox

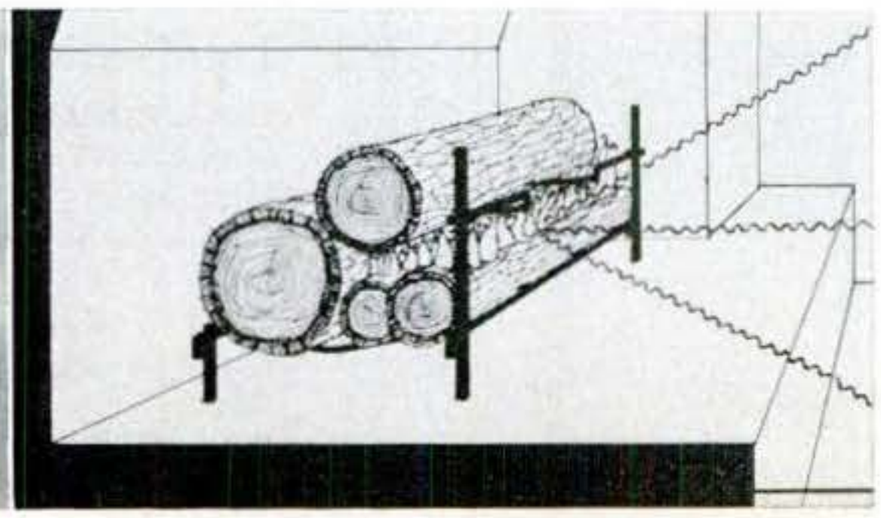
Mounted roadside on a post or next to your front door, this lockable mailbox should keep letters and parcels secure. Of 22-gauge-sheet-metal construction, Mail Safe II measures 15" by 13" by 6". It's $19.95 from Babco, 11450 Sheldon St., Sun Valley, Calif. 91352.

Drawers

Drawermaster frame and roller assembly lets you install drawers between studs under stairs, attic knee spaces, etc. Drawers come in 16" or 24" depths. Prices range from $30 to $42. Fronts and knobs not included. Drawerkit Sales, Box 36, Alden, Mich. 49612.







Fireplace grate

The physicist-inventor of the Texas Fireframe says this grate can triple heat output—the slot-like cavity radiates heat into the room rather than up the chimney. An economy model costs $29.95; heavy-duty, $39.95. Texas Fireframe Co., Box 3435, Austin, Tex. 78764.

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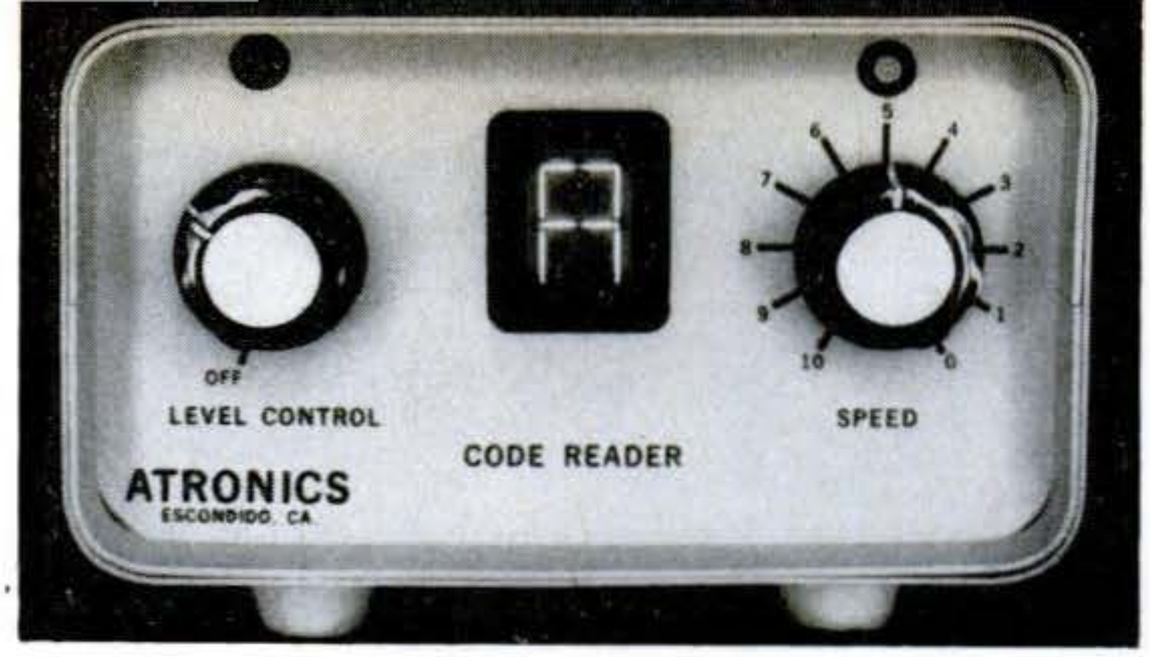
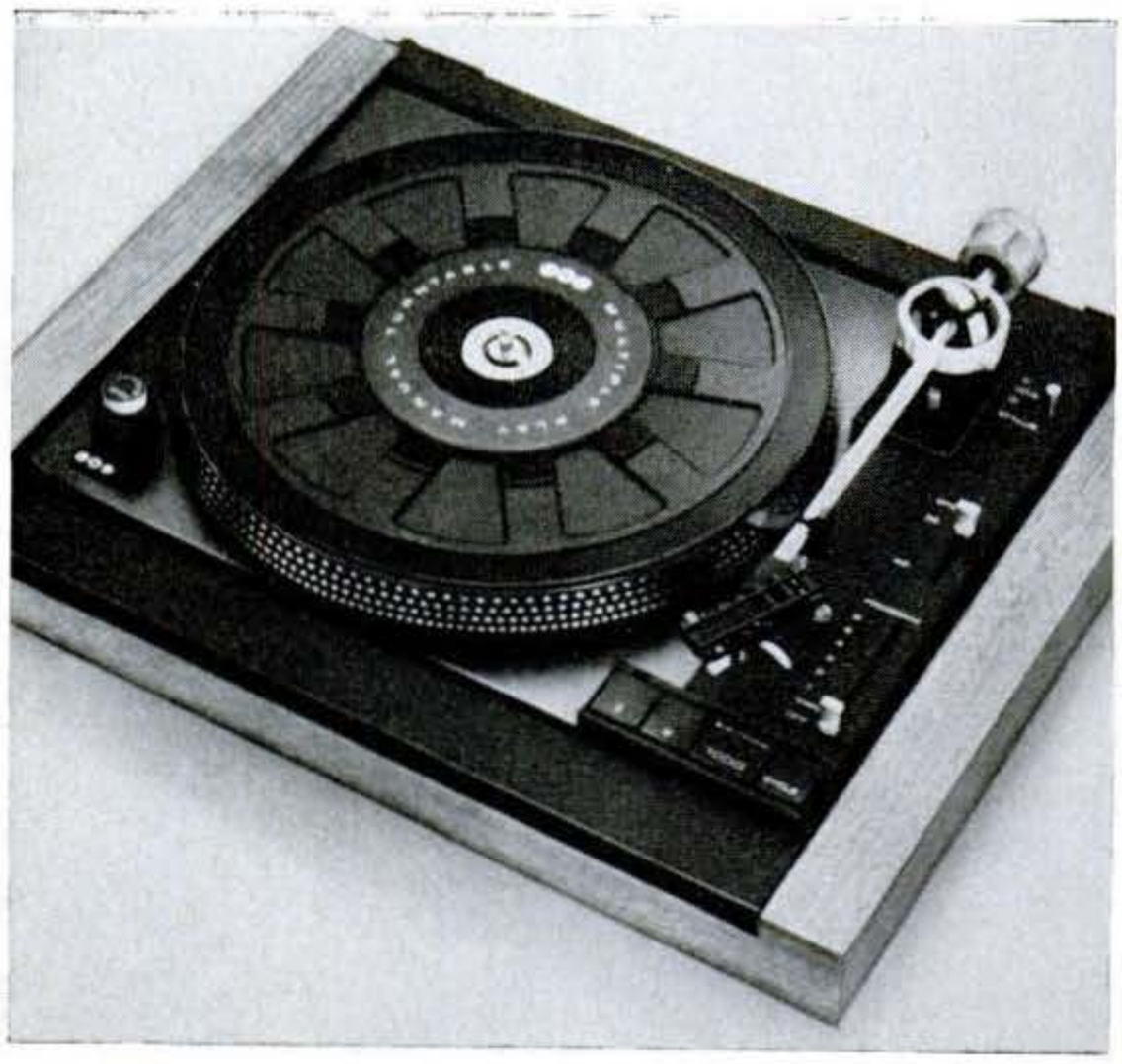
What's New IN ELECTRONICS

BY WILLIAM J. HAWKINS



Morse de-coder

Attach this clever box to the speaker terminals of your communications receiver and it will translate dots and dashes of Morse code into English. Digital readout displays message automatically as it is received. It's $225 (built), $125 (kit), from Altronics, Box 77, Escondido, Calif. 92025.

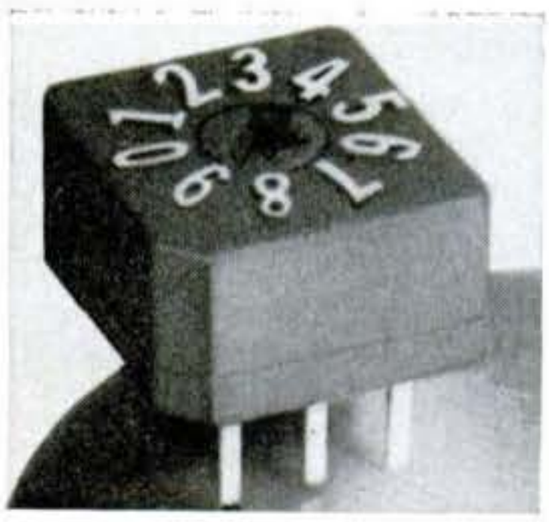


Dual-control player

Start, stop, cue, pause, reject—all the buttons you'd expect to have on any turntable? True, but this new BIC 1000 has them on a wired or wireless remote control as well. Turntable is $279.95. Wired remote adds another $20; wireless adds another $50.

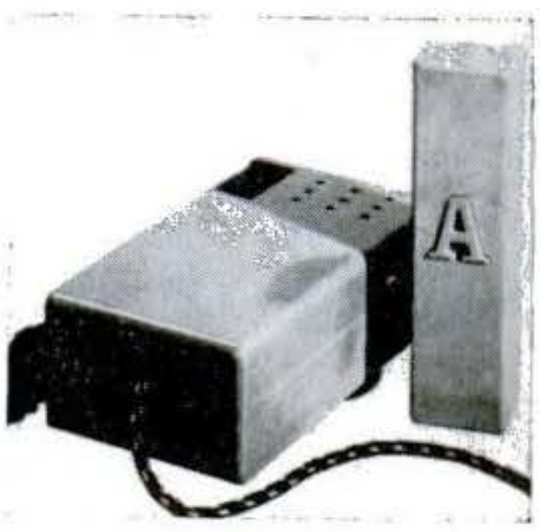
40-channel CB

This CB rig from GE has 17 more channels: Model 3-5817 is one of the first units approved by the FCC for 40-channel use. Features include LED channel readout, S/RF/SWR meter, noise blanker, and antenna-trouble warning light. Price is $219.95.



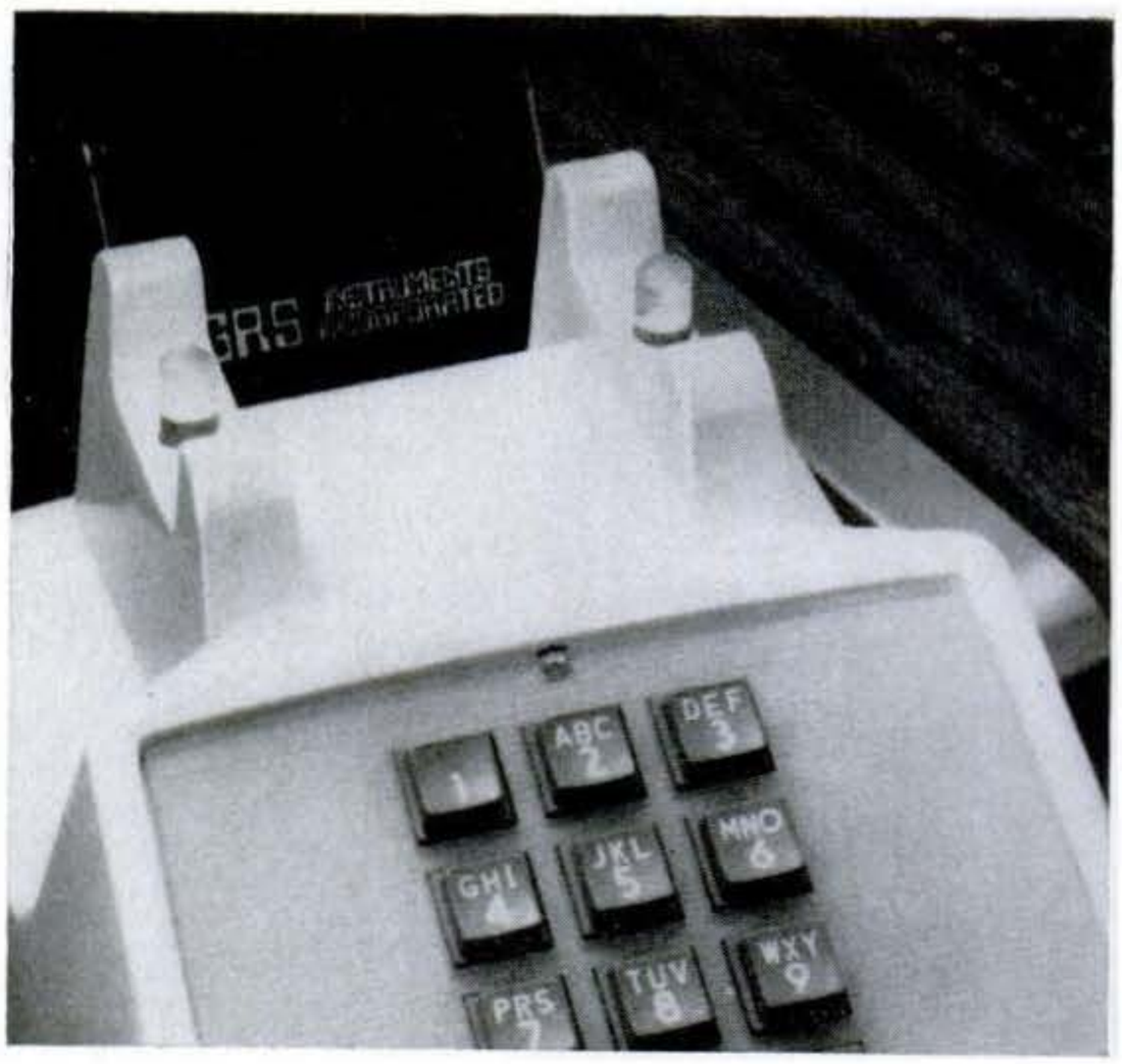
Mini switch

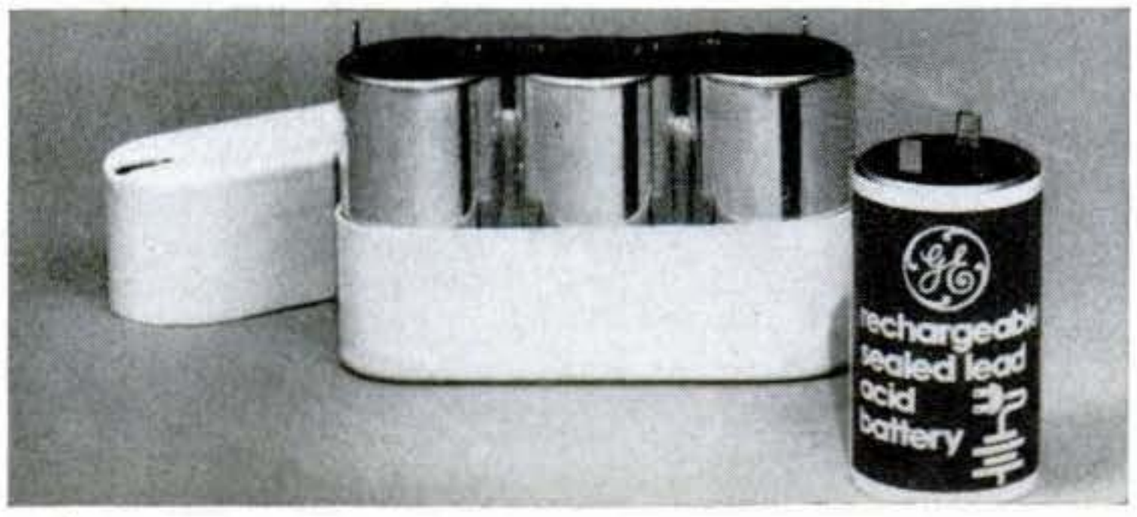
Here's a small package to solve a big problem—manual switching. Micro-Dip fits in a standard in-line chip socket and gives a direct BCD output for each of its 10 positions. From EECO, 1441 E. Chestnut Ave., Santa Ana, Calif. 92701.



Remote control

Press the "A" on that wireless transmitter and its receiver (left) will turn on lights, the TV, your hi-fi—whatever's plugged into it—from a distance of 100 feet. From Neil Henson Co., 1 Elmwood Lane, Westport, Conn. 06880. $25.95.





Lead-acid battery

Not just another rechargeable battery, this is one of GE's latest rechargeable lead-acid "D" cells (six- or 12-volt models are available). It offers high current and a longer discharge time. Sealed case (except for pressure venting) allows it to be used in any position.

Phone timer

Time is money—especially on the phone. Add this GRS timer, however, and its LED digital display will show you when the three-minute mark is coming up. It's $31.95 from GRS Instruments, Inc., 8730 King George Dr., Dallas, Tex. 75235.

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What's New
FOR YOUR CAR

BY RAY HILL

Hatchback conversion kit

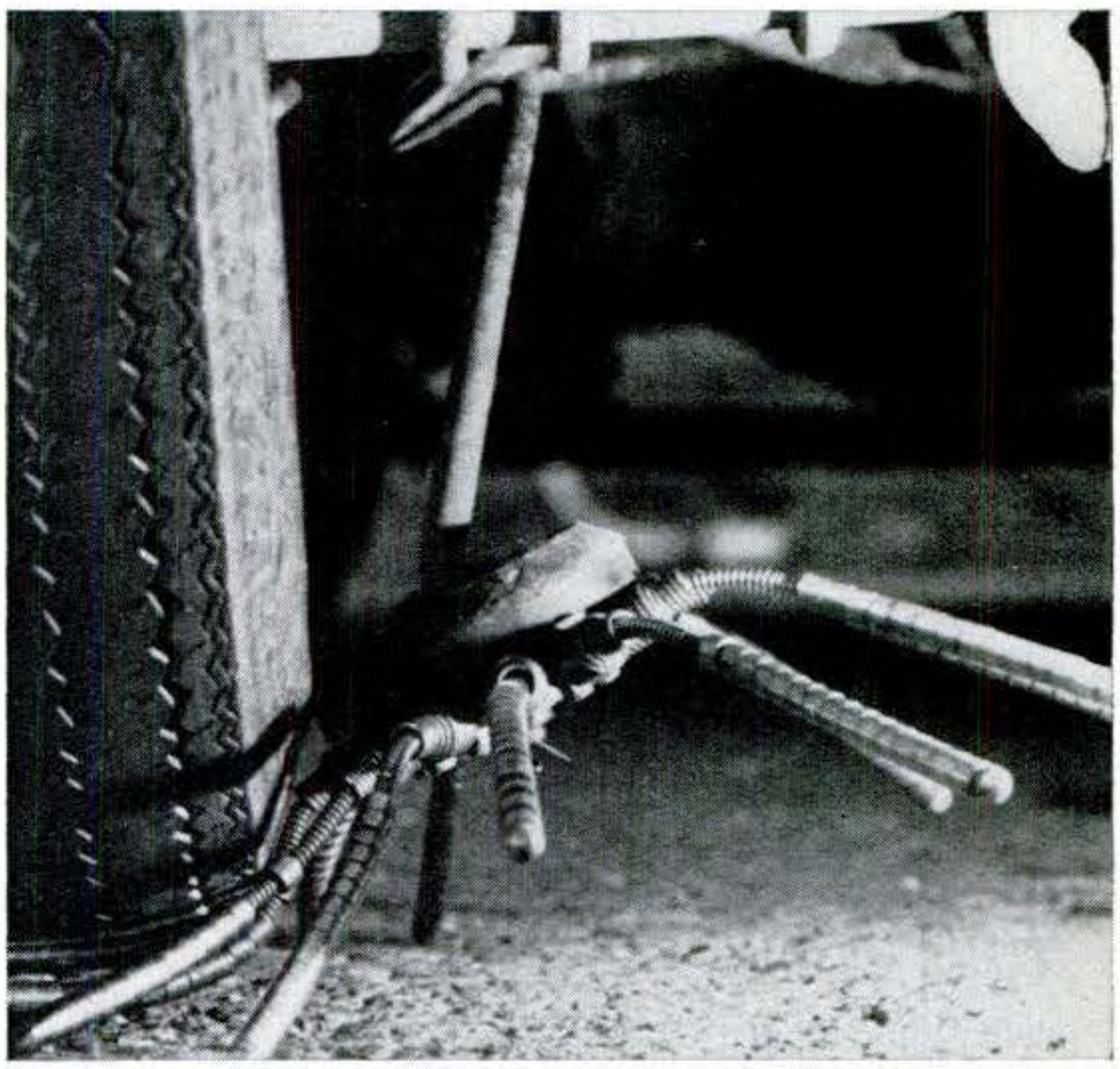
Own a Datsun Z? You can double the little hatchback's space. Kit consists of three finished urethane panels and a urethane-foam seat that seats two. The maker says the kit can be installed in 10 minutes. The seat is covered in the same textured vinyl found in Datsun interiors, and can be ordered in saddle brown, black, or white. When not in use the sections fold flat. Future kits will fit Toyota, Datsun B-210, and Porsche 924 hatchback models. The Datsun kit is $470; it's available from Consolidated Int'l. Automotive, 13010 S. Broadway, Los Angeles 90061.

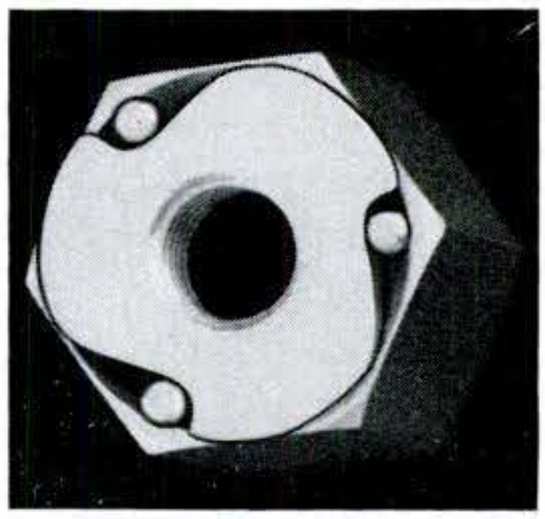
Air deflector

Got a car without vent windows? Vent-Aire is designed to deflect air in as a vent would. It's made of heavy-gauge Plexiglas mounted on chrome-plated hardware, and swivels on a ball joint. Rosco, Inc., 144-31 91st Ave., Jamaica, N.Y. 11435.

Traction aid

Want instant traction on mud, snow, or ice? Press a button on the dash and the Traction Spider goes to work. Press again and it retracts. It's $150 from Paul-Scott Sales, Box 2085, Brockton, Mass. 02403.





Hot-beverage maker and dispenser

Engine heat gets a new use with this device. It mounts on the floor of your car or on the engine cowl of your van and makes hot water for your beverages. The Car-ffee circulates the engine's coolant through a double-walled heat exchanger. The heat exchanger runs through the Car-ffee's water-supply tank, thus warming the water. No special tools required for installation. Car-ffee serves about 20 cups of hot water before its one-gallon tank needs refilling. It's $89.95 from Arel Ind., Box 422, Lake Villa, Ill. 60046.

Lamp lock

These antitheft bolts can be installed in place of the original mounting bolts on Cibie quartz-halogen bolt-on lamps. Their unique shape prevents unauthorized removal—only you have the wrench keys. From Efpe Co., 33195 Harper Ave., St. Clair Shores, Mich. 48082.

Fuel-line cap

Slip this device over the end of an open fuel line and it keeps gas from dripping. It's useful when you change fuel pumps, carburetors, or engines. The fuel-line closer is made by Thexton Mfg. Co., 7685 Parklawn Ave., Minneapolis, Minn. 55435.

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'77 outboards

–new brands, new models, new hp range

U.S. makers are getting competition from slick new low-priced models

By JIM ROE

It's an unusually big year for outboard-motor news, with more manufacturers and models than ever before. The highlights for '77 include:

- New 175-, 140-, and 25-hp motor from Johnson and Evinrude.
- A new 70-horse outboard from Mercury Marine.
- Chrysler's new single-cylinder four-horse model.
- Two new manufacturers—Mariner and Spirit.

Mariner aims to "expand the total U.S. outboard-motor market with a bold new approach unfettered by traditional marine business patterns," says Robert C. Andfegg,

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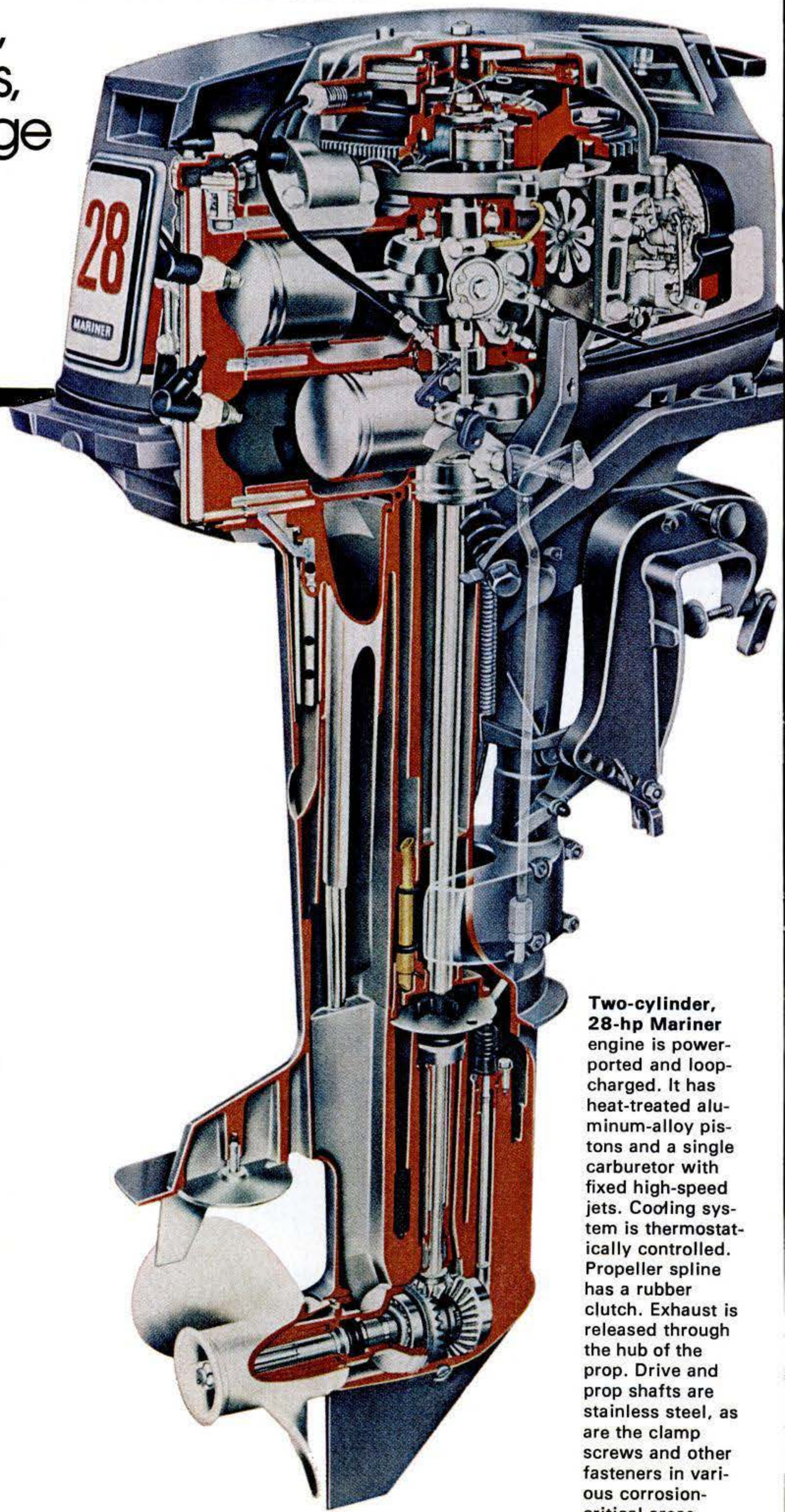

Two-cylinder, 28-hp Mariner engine is power-ported and loop-charged. It has heat-treated aluminum-alloy pistons and a single carburetor with fixed high-speed jets. Cooling system is thermostatically controlled. Propeller spline has a rubber clutch. Exhaust is released through the hub of the prop. Drive and prop shafts are stainless steel, as are the clamp screws and other fasteners in various corrosion-critical areas.

High-thrust 10-hp Sailor from Chrysler is designed to help propel and stop sailboats in tight quarters. The anticavitation plate near water surface isolates exhaust for greater reverse thrust.

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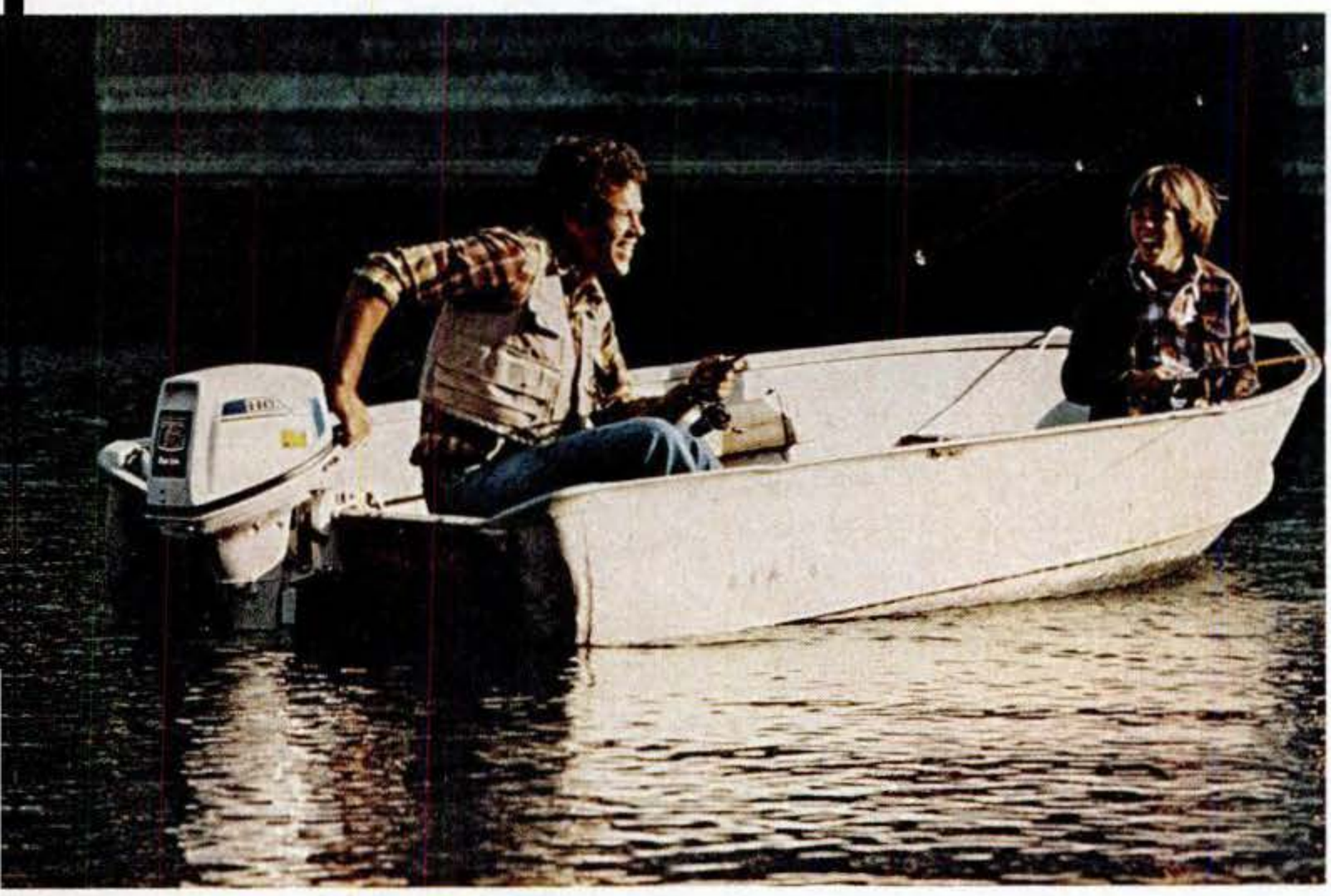
New 175-hp V6 from Johnson is sister to the 200-horse, biggest in the world. Both displace 149.4 cubic inches. The 175-horse is available with standard 20-inch shaft, or long 25-incher.

A 200-hp powerhouse is at the top of Evinrude's line. It's a 90-degree V6, with pulse-tuned exhaust, built-in power trim, and other goodies needed for top outboard performance.



Japanese-built Spirit 20 hp is sold by Arctic Cat. Other Spirit models range from 2 to 50 hp. Prices for the Spirit outboards will average about 10-percent less than equivalent U.S. models.

Small 7.5-hp model is only outboard sold by Honda in the U.S. It is a four-stroke water-cooled engine that does not require mixing of oil and gas. Top hp develops at 6000 rpm.

Second largest outboard from Mercury for '77 is the 150-hp, V6 model 1500. The Wisconsin engine builder also offers the powerful 175-hp Black Max, and motors down to the four-hp Gnat.

The 60-hp Mariner outboard, built at Yamaha plant in Japan, is big brother to the 28 shown in cutaway at left. Mariner's biggest import, the loop-charged 60 displaces 46.47 cu. in.

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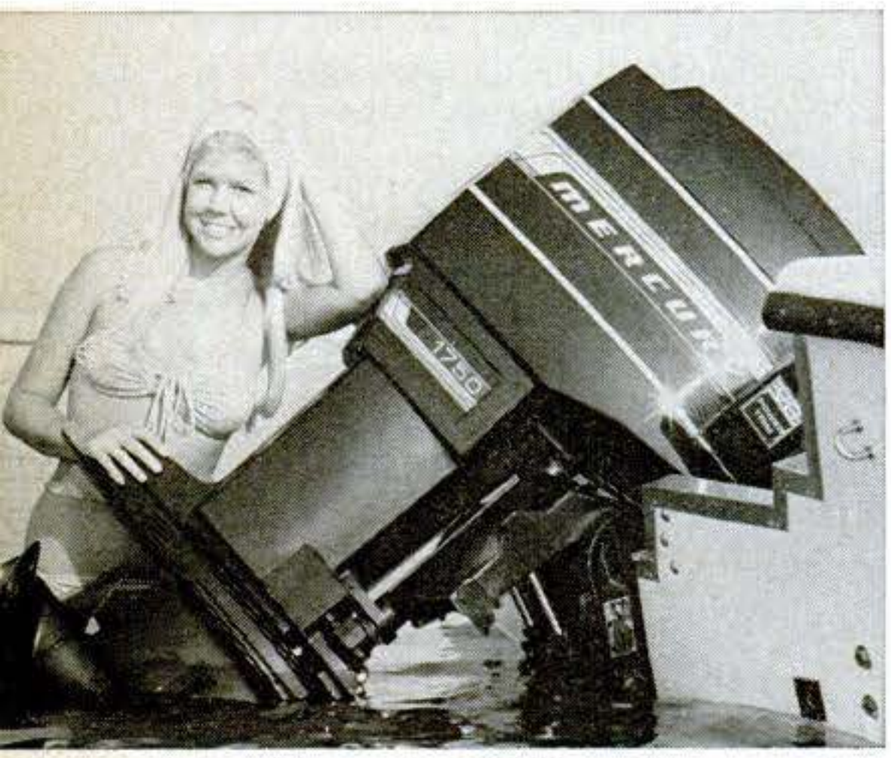
the company's general manager. Unfettered perhaps, but not unfamiliar. Mariner is a sister company to Mercury Outboards.

The Mariner motor is a joint effort of Brunswick and Yamaha. The motors distributed here range from two hp to 60 hp, and will be built in Japan. The top-of-the-line 85 will be built in Fond du Lac. Mariners are two-cycle marine motors, similar to most other outboard motors manufactured and distributed here. Advance word is that they will be priced five to eight percent below most U.S. models of similar horsepower.



Loop-charged 175-hp Mercury has Thunderbolt CD ignition, with perma-gap spark plugs that are 360-degree firing and self-cleaning. Three fixed-jet carbs supply correct fuel/air mix.

Top of the line from Chrysler is this 135-hp model. The four-cylinder engine displaces 99.9 cu. in. It features magnapower breakerless ignition. Chrysler also offers a 96.55-cu.-in. 120-hp engine.

Besides its four-cylinder 85-hp model, Mariner is offering two-cylinder 60-, 28-, 20-, 15-, and 8-hp models, and single-cylinder 5-, 3.5-, and 2-hp mills.

Engineering features have a familiar ring: The 66.6-cu.-in. four-cylinder Mariner 85 has a solid-state CD ignition system, electric start and choke, twin carburetors with fixed high-speed jets, a pressure-controlled cooling system, and through-prop exhaust. Power trim is optional.

The two-cylinder 60-horsepower Mariner is a 46.37-cu.-in. motor, with most of the same features as the 85. Drainless crankcases are standard on all models; all except the 85 hp are loop-charged. CD ignition is standard on the 85 hp and the 60 hp; the other seven models are geared by a flywheel magneto. Battery charging by means of a flywheel alternator or rectifier is standard on the 85-horse and 60-horse; optional on the 28, 20, 15 and 8. Weight ranges from 245 to 20 pounds.

All Mariner models below 48 hp have low-tension ignition instead of CD. Models below 28 hp have shear-pin drive and no through-prop exhaust.

Spirit

Spirit will hit the U.S. market with seven outboards ranging from two to 50 hp. The Spirit line, built by Suzuki, is distributed by Arctic Enterprises, Inc., of Thief River Falls, Minn. (which also makes Arctic Cat Snowmobiles).

Arctic spokesmen tell us that prices throughout the line will average 10 percent less than comparable American models.

Spirit's seven models are rated at 2, 4.5, 9.9, 16, 20, 25, and 50 hp. Innovations include an optional battery-charging and lighting coil for the two-horse, flywheel mag with auto timing advance for the 9.9- and 16-hp models. The 20-, 25-, and 50-horse models have a CD ignition system with timing advance. A remote manual choke comes with the 50-horse motor. The 12-volt 6.6-amp coil is standard on the 9.9-, 16-, 20-, and 25-horse models. Four of the motors are available in three shaft lengths: 15 in., 20 in., or 25 in. for the 9.9- and 16-hp models; 15 in., 20 in., or 23 in. for the 20- and 25-hp motors. Another innovation is propeller selection for the two-hp model.

The heavyweights

For 1977, Evinrude and Johnson have introduced a new 175-hp motor, a cousin of the 200-hp model launched last year. Both motors are V6 with 149.4-cu.-in. displacement. The 175 delivers maximum horsepower at 5000 rpm; the 200, at 5250 rpm. Practically all other engineering features are the same.

As I predicted [PS, Aug. '75], these big engines have proved very popular with people who like big new 20- to 25-foot sport fishermen and day cruisers.

The 175-horse Johnson and Evinrude will compete with Mercury's 175-hp Black Max, also a V6.

Johnson and Evinrude also offer two new 140-hp V4's; their five-horsepower increase over last year's 135 is due to the new tuned megaphone and a larger expansion chamber in the inner exhaust housing. Displacement is 99.6 cu. in.

Midrange outboards

Three new motors are being introduced in this category for '77: a new 70-horse Merc and 25-horse models from Johnson and Evinrude.

The Merc 70 replaces last year's 65-hp Merc 650. It's a three-cylinder with 49.8-cu.-in. displacement.

The Johnson and Evinrude 25's of last year have been completely redesigned. This year's 25's feature a new powerhead with 31.8-cu.-in. displacement, which develops its rated horsepower at 5000 rpm. Company engineers say that this larger powerhead results in faster acceleration, more low-end pulling power, and increased top speed. These engines also have breakerless electronic ignition for smoother idling and more consistent low-speed operation.

Chrysler has a new single-cylinder four-hp with more big-motor styling and features than anything Chrysler has ever offered in this size range, according to the company. It's loop-charged, with an integral fuel tank that holds an hour's worth of fuel. The motor is water cooled, and swings a three-blade propeller with a two-to-one gear ratio. Displacement is five cubic inches. This newest Chrysler baby has forward and neutral gear shifts, and 360-degree pivot steering. The rewind starter is mounted up top. The whole motor, including a front carrying handle, weighs in at just 35 lb. It's available with a 15- or 20-in. leg. With the longer leg, a 12-volt alternator is standard equipment. On the 15-in. model, the alternator is available in either 60-watt AC or 30-watt DC capabilities with a rectifier for battery charging and lights. PS

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Kevlar boats

Say goodbye to fiberglass?

Synthetic fiber, for lighter, stronger—but costlier—boats, is making waves

By A. J. HAND

Fiberglass, the core of modern hull construction, is now obsolescent. It's being eclipsed by a new hull material some 25-percent lighter, 50-percent stronger, and 50-percent stiffer. This new hull material is Du Pont's Kevlar, the strongest synthetic fiber in the world, stronger even than graphite fiber [see PS, April '75]. Kevlar comes in three forms or "alloys." The first form, basic Kevlar, was developed to replace steel in steel-belted radials. Another form, Kevlar 29, is used for ropes, cables, bulletproof vests, and sail cloth.

Kevlar 49—the stiffest and strongest of the alloys—is used as a reinforcement for epoxy or polyester resins. It's this form of Kevlar that threatens the future use of fiberglass in hulls.

Kevlar first paddled onto the boating scene back in July, 1973, at the World Championship canoe and kayak races. There, Kevlar boats won several medals, including a gold. The word got around and today a dozen canoe and kayak makers are building with Kevlar.

In 1975, Kevlar made its power-boat debut in a tunnel-hull racer and a high-performance bass boat, both by Hydra-Sports. The tunnel hull won the APBA National Sprint-Marathon Championship for its class, and the bass boat set a national straightaway speed record for 85-horsepower engines. Hydra Sports was impressed enough with these prototypes to go into mass production of Kevlar bass boats.

No fish in these waters—so Skeeter's Wrangler HP-150 bass boat takes off (top photo). Like all Skeeters, it comes with an optional, high-strength hull that features Kevlar reinforcement. Scarab offshore power boat (above), reinforced with Kevlar, weighs 15-20 percent less than the fiberglass version. Result is a three- to five-mph increase in top speed—and a $2500 price hike.

Kevlar is also beginning to show up under sail. Alex Kosloff's Kevlar C-Class cat won the Little America's Cup. Three of Dick Newick's VAL-class trimarans with Kevlar reinforcements participated in the 1976 Observer Single Handed Transatlantic Race. They placed second, eighth, and 46th in a fleet of 125.

And Kevlar is showing up in offshore racing boats, including the Kevlar 38-foot *Copper Kettle* by Bertram, and Scarab Marine's 29-foot *Scarab*.

How Kevlar does it

Kevlar has so many advantages it could begin to show up in many more boats before long. Here's why:

- Kevlar is, pound for pound, more than twice as strong as glass. This lets a boat builder make lighter, yet stronger boats. Reduced weight may improve performance.

Continued

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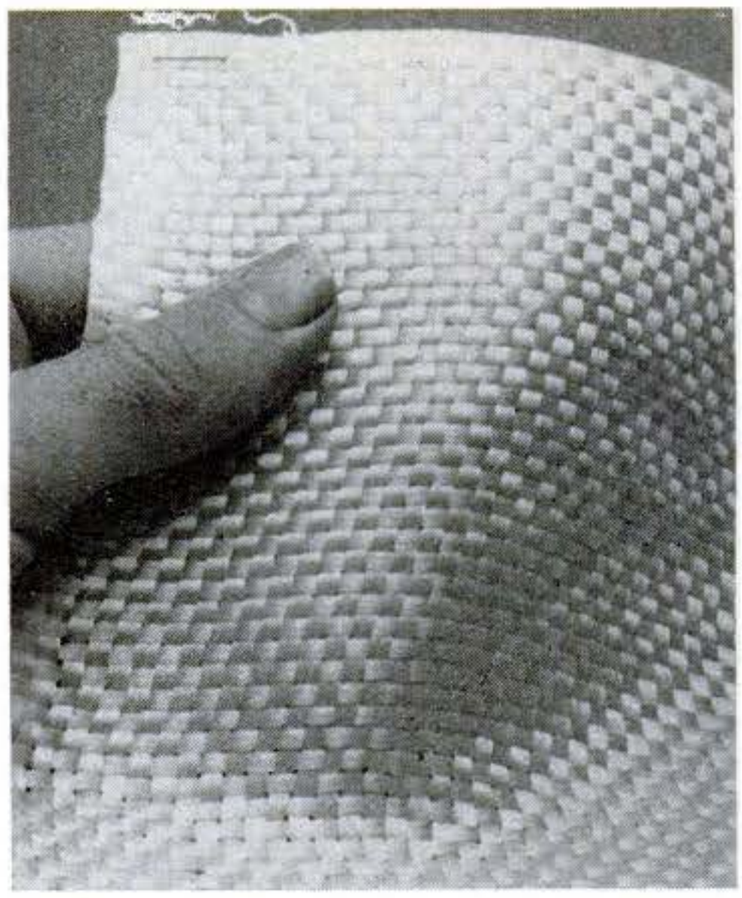
Crossarms on trimaran transatlantic racer by Dick Newick are Kevlar-reinforced on the undersides, which are under tension on lee side when boat heels. Since Kevlar is weak under compression, upper surfaces are graphite-reinforced.

Kevlar—how it stacks up against other materials

Kevlar is a synthetic fiber made from oil, and a member of a new family of fibers classed by the FTC as aramids. Chemically, Kevlar is an aromatic polyamide (a complex hydrocarbon). Physically, it's the strongest synthetic fiber in the world. It is five times stronger than steel on an equal-weight basis, and its strength is higher than any fiber, man-made or natural. It stands a full 20 percent above its nearest competitor, high-strength graphite. It is so strong, in fact, that only when laminated with epoxy-type resins can its true boat-building potential be realized. When bonded with cheaper polyester or vinyl ester resins, the bonding resins will fail long before the Kevlar is loaded to its breaking point.

When bonded into a laminate, Kevlar will not degrade in fresh or salt water or lubricating oils. It doesn't expand or contract as temperatures change. It is inherently flame-resistant, is self-extinguishing, and will not melt. It has a useful long-term temperature range from minus 320 to 320 degrees F.

Kevlar handles like most other synthetic fabrics. It can be woven easily, but, unlike fiberglass, it can't be chopped and shot from a gun; only hand layups will work. So don't expect it to show up in cheap, gunned boat hulls.



Kevlar woven roving costs about $14 per yard, versus $1 for fiberglass. So the super-strength stuff is used mainly in canoes, where light weight is key, and in high-performance boats, which are built with speed—not cost—in mind.

It also means lower fuel consumption in power boats, and easier paddling and portaging in canoes and kayaks.

- Kevlar is also three times as stiff as glass. Again, this helps reduce hull weight by cutting the need for heavy stiffening members. It also means a high-speed hull is less likely to distort or take a hook at speed (a hooked hull arches up amidships and hurts performance).
- Kevlar has good vibration-damping characteristics. This gives a more comfortable ride; and instruments attached to the hull are more reliable, too.
- Kevlar is resilient. A solid blow that will shatter a hole in a glass hull may only dent a Kevlar hull. And the dent will probably pop back out. D. J. Charles of Pinetree Canoes told me about a Kevlar canoe that was crushed flat amidships over a year ago. It popped back into shape and is still in use today . . . no repairs required.
- Kevlar doesn't fatigue with age as glass does. Result: increased hull life and resale value.

But nothing's perfect

If all this sounds too good to be true, be assured: Kevlar isn't without its drawbacks.

- Most obvious is its cost. Kevlar construction might increase the cost of a canoe by about $125. In a bass boat, Kevlar can cost you $300 to $500 more. Even so, customers seem willing to pay to get Kevlar. Hydra-Sports offers its bass boats in a choice of glass or Kevlar. Early sales were about one-third glass to two-thirds Kevlar. As

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Kevlar racer from Mad River Canoe placed first in its class at the 1976 National Open Canoe Championships. Made of 100-percent Kevlar, the canoe weighs about 20 pounds less than its glass counterpart—and costs $250 more.

Kevlar's reputation has grown, the ratio has changed. Now Hydra-Sports builds 93 percent of its boats with Kevlar.

- Kevlar is more difficult to work than fiberglass. Cutting it in its fabric form requires very sharp, serrated shears. Once it has been laminated with resin, it's even tougher. High-speed air saws, with diamond blades that go through glass laminates like soft butter, can barely chew through Kevlar. The use of newly developed tools has reduced—or eliminated—most of Kevlar's handling problems. But, repairs on Kevlar—though seldom required—call for some of those special tools. Most boatyards don't yet have them.
- Kevlar is trickier than glass to lay up (prepare for lamination). Glass cloth—white when dry—turns transparent when wet with resin. Any bubbles of air under the fabric are easy to see and to work out. Kevlar is a nearly opaque yellow, even when wet with resin. Bubbles are invisible, so a layup man has to work very carefully to avoid them. If he doesn't, the result is a weak spot subject to delamination. The problem is compounded by Kevlar's poor cloth mobility (its resistance to conforming to compound curves), and its tendency to float on resin.
- Despite Kevlar's tremendous tensile strength, the stuff is relatively weak in compression. This isn't a problem in hull construction, but it can pop up in other places.

As you can see, most of the problems that come with Kevlar are builder problems, not user problems. When experience with the stuff grows, the problems will begin to fade away. As Dick Newick puts it: "Twenty years ago, boatbuilders using wood had trouble understanding glass, too."

How builders use it

Kevlar can be built into boats in a couple of ways. In small craft such as canoes and kayaks, where cost of materials is lower, you can find all-Kevlar construction. Here, weight savings can amount to as much as 50 percent with no sacrifice in strength.

In most cases, however, it does not entirely replace glass. Larger boats would be too expensive if built entirely with Kevlar. Rather, a Kevlar woven roving fabric replaces a layer of glass roving. (Other glass/Kevlar blending techniques are used, but since Kevlar technology is new, boatbuilders are reluctant to reveal the special layup techniques they have developed.)

For the near future at least, glass/Kevlar mixes will predominate. As a result, most Kevlar bass boats offer weight savings of only about 15 percent, but with a significant increase in strength. Lighter hulls are certainly possible, even with hybrid construction. But as David Newton of Hydra-Sport explains, "Because of the lack of history with Kevlar, we do not try to squeeze the last ounce of potential weight savings out of the material."

Above-deck

The use of Kevlar in boats is certainly not limited to the hulls. It is now being evaluated for use in masts. And tests with unidirectional Kevlar fabric indicate that a mast half the weight of an aluminum spar—yet stiffer—is possible.

Kevlar can also be used for sailboat stays instead of stainless, for a significant drop in weight. Reducing above-deck weight increases stability.

Kevlar also has potential as a sail material. The first attempt at Kevlar sailmaking—the bright yellow sail for *Courageous*, the 1974 America's Cup defender—was a disappointment. But the failure of that sail was due to a poor cut and lack of Kevlar design experience.

The future? The big hangup with Kevlar is cost. Right now, Du Pont is the only producer of Kevlar. Competition from another source could bring the price down.

Ty Choate of Skeeter sums it up: "I believe Kevlar is the boat-building material of the future. Cost is prohibitive now. But just as nylon and rayon finally resulted in a better, yet less-expensive substitute for cloth, so, I believe, will Kevlar replace glass." PS

Kevlar boats: who makes them

CANOES AND KAYAKS

Easy Rider Boat Co., 10013 51st Ave., SW, Seattle WA 98146; **Lincoln Canoes, Inc.,** Route 32, Waldoboro ME 04572; **Mad River Canoe,** Box 363, Spring Hill, Waitsfield VT 05673; **Old Town Canoe Co.,** Old Town ME 04468; **Perception,** Box 64, Liberty SC 29657; **Phoenix Products,** Tyler KY 40486; **Pinetree Canoes, Ltd.,** Box 824, Orilla, Ont., Canada L3V6K8; **Ranger Canoes,** Route 110 and Allen St., Clinton ME 01510; **Sawyer Canoe Co.,** 234 State St., Oscoda MI 48750; **Seda Products,** Box 41B San Ysidro CA 92173; **6-H Products Ltd.,** Box 758, Kingston, Ont. Canada; **Wabash Valley Canoes,** 506 Road 225 W, Crawfordsville IN 47933

SAILBOATS

Newick High Performance Boats, RFD, Vineyard Haven MA 02568; **Performance Sailcraft, Ltd.,** 91 Hymus Blvd., Pointe-Claire, Que. H9R1E2.

POWERBOATS

Bertram Yachts, 3663 NW 21st St., Miami FL 33142; **Scarab Marine,** Smith Elliott Assoc., 4242 Lincoln Blvd., Marina del Rey CA 90291.

BASS BOATS

Ebbtide Corp., Jones Creek Rd., White Bluff TN 37187; **Hurst Enterprises,** 901 Central Florida Parkway, Orlando FL 32809; **Hydra Sports Tournament Boats,** 1011 W. Kirkland Ave., Nashville TN 37216; **Mackie Boats,** Box 672, Wake Forest NC 27587; **Skeeter Boats,** Box 1602, Kilgore TX 75062; **Stryker Boats,** 5010 Beechmont Dr. NE, Huntsville AL 35811.

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Ready for the ultimate sailing experience? Try **windsurfing**

No, they're not falling. In a stiff breeze, windsurfers bend backwards precariously to balance wind force and stay up.

By C. P. GILMORE

There I was on a cold, rainy day on Cape Cod. The rain kept running into my eyes, and I kept capsizing and falling into the water. But I didn't want to quit.

I have sailed everything from Sunfish to 30-foot cruisers for years. But I'd never done anything like this before—what may be sailing in its purest form: windsurfing.

A windsurfer is about as simple a sailing machine as you can get. It consists of a 12-foot-long hull, similar to an ordinary surfboard, with a daggerboard in the center slot. A small fixed stern fin makes it easier to steer. A 14-foot fiberglass mast slips into a socket on the board. On the mast is mounted a 56-square-foot dacron sail, and straddling the sail is a nine-foot-long spar. You hang on to this, use it to trim and rake the sail.

Getting underway is simple. You wade out into knee-deep water and slip the universal joint at the bottom of the mast into the slot on the board. The sail and mast are in the water. You step up onto the board—carefully, it's tippy—grab the rope attached to the front of the spar, and pull the sail up.

The wind is at your back, the sail is luffing idly directly downwind—at right angles to the hull. Now, in one quick movement, you reach over, grab the spar, and pull the sail to a position nearly at right angles to the wind. You suddenly accelerate as the wind grabs the sail. Since most of the sail area is behind the center of balance, the sail tries to weathervane and point the surfer sharply into the wind. You counteract by raking the mast sharply forward as you sheet it in—pull it to a position nearly parallel to the hull. Thus you thwart its tendency to head up (into the wind) and keep it clipping along on a reach (across the wind).

Steering is easy; you just change the dynamic balance of the sail. Tip it forward and the wind exerts more pressure on the bow than on the stern, so the bow falls off—heads away from the wind. Tip the sail back and the boat heads up.

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Windsurfing may be one of the easiest ways to get into sailing. First, it's cheap; a windsurfer complete costs $575. And second, it's relatively easy to learn.

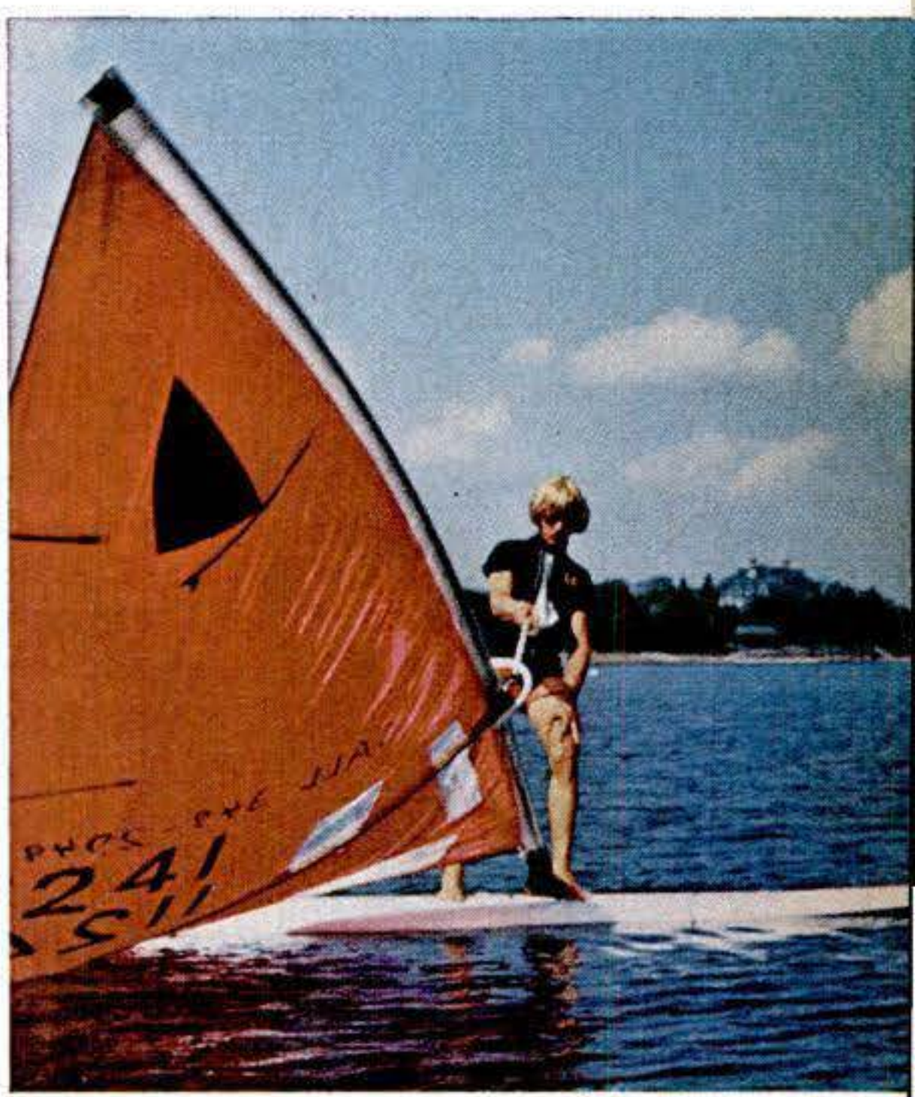
But you're certainly in the water a lot as you learn. I was beginning to feel pretty cocky after my first five minutes. I had tacked several times with no trouble. Then suddenly, a gust of wind hit me and I was in the water without quite knowing how I had got there.

Oddly, the better I did, the more time I spent in the water. The reason is simple; I began to take more chances—to hang out under the sail where you get the greatest speed, but also sail nearest to disaster.

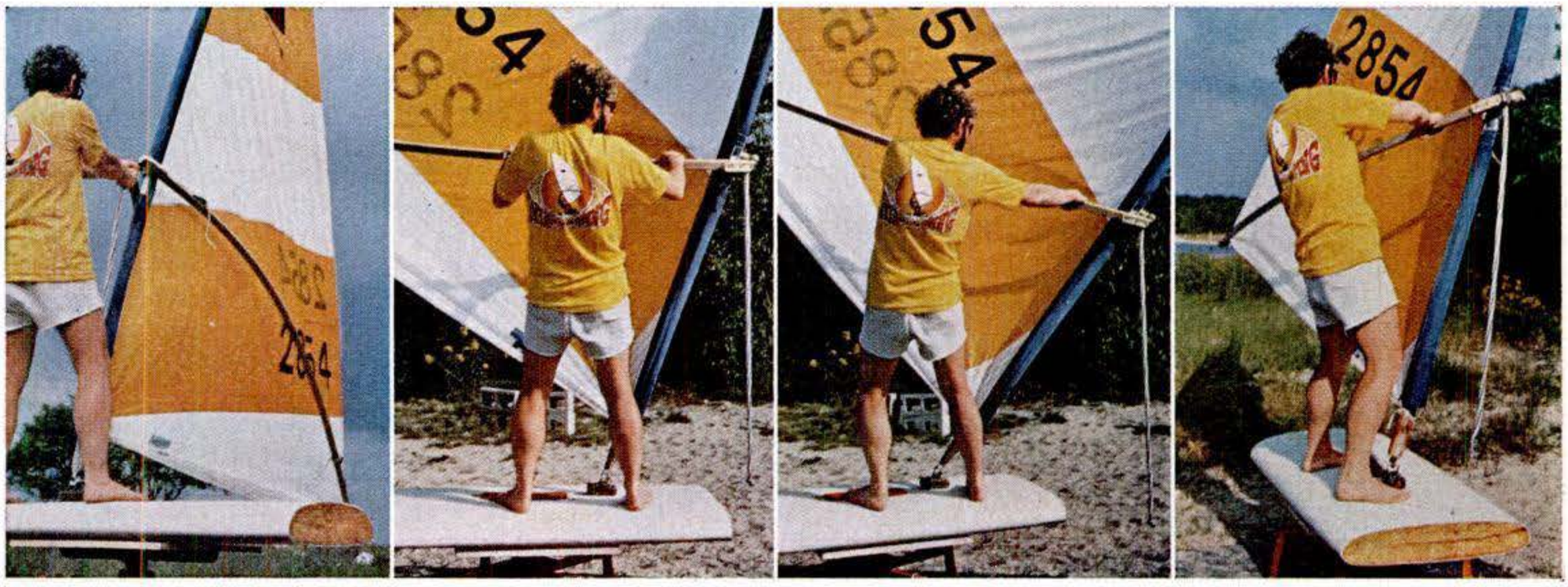
I got started in windsurfing by accident. I'd been thinking about it for some time when I happened to meet the Cowan brothers—Rick and Steve—at the Stamford, Conn., boat show last fall. They invited me up to Cataumet, Mass., where they run a company called Windsurfing Cape Cod, which sells Windsurfers and gives lessons. I had my early lessons on their land-based trainer, plus some in-water experience.

The weather turned nasty and the season ended last fall when I had only a few days of windsurfing. But I'm afraid I've been bitten. On those first chilly days in the next few months when there's a hint of spring in the air and when the ocean creeps up to maybe 52°, I'll be getting into my wet suit and out on the water again on a windsurfer.

You can purchase a Windsurfer from Windsurfing International, 1038 Princeton Drive, Marina Del Rey, Calif. 90291, or Windsurfing Cape Cod, Box 335, Cataumet, Mass. 02534. PS



At start of race (top) windsurfers jockey for position. Two Cowan brothers demonstrate outstanding technique on tandem board (above, left) used mainly for teaching. Windsurfer gets underway (right) by hoisting sail out of water.



First lesson comes on simulator, a swiveling board that acts much like actual board but keeps you drier. Sequence shows basic maneuvers. Pull sail up, luffing in wind (1). To get underway (2) sheet in sail with wind at back. Head down—away from wind—(3) by tilting sail toward bow. To head up—into wind—(4) tilt sail toward stern. Simulator swings realistically as sail is maneuvered, giving feel of windsurfing so beginner learns fundamentals on dry land.

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Ski hull
takes the bounce out of boating

Two skis on automotive-type suspensions give these small boats a limousine ride

By DAVID D. VIGREN

The 18-foot fiberglass prototype was running at 35 mph over a hard chop on only the keel and two wood skis. Control at this speed was excellent, and here on the water it seemed entirely natural to experience what inventor Don Pensel had quietly, methodically said about the design and performance of his ski hull. I had first felt somewhat doubtful. The boat moved in a new way, with strange sensations. Now I was used to it, and accepted my limousine ride as predictable. A new hull design that is also broadly practical is a rarity. Could this be one of the few?

"I was not at all sure what I would uncover when I started the project," Pensel said. He reckoned that mounting long, narrow skis with shock absorbers on a deep-V hull should lift it high in the water to smooth the bouncing that often takes the fun out of runabout boating. It would reduce water friction, which limits speed, and give people a dry ride as well.

Pensel has built two models so far —a 12-foot outboard and an 18-footer with stern drive. Both have acute 35-degree hulls that rise up to boxy shoulders where suspension parts are mounted. Each ski is attached to an independent trailing-arm suspension system with an automotive coil spring and shock absorber, which is bolted to a steel frame just inside the sheer line on either side. The skis are free to pivot vertically, but are spring-loaded to keep toe-up in the water. Trailing arms prevent any substantial horizontal movement of the skis.

New performance traits

In Dunham's Bay on nearby Lake George we had to wriggle into the narrow cockpit between the shoulders of the 12-foot plywood model—the 35-degree V is only 40 inches wide where it meets the horizontal section. At five mph the boat fishtailed, just about as a jet boat does —a result of drag on the submerged skis. But when Pensel shoved the throttle forward, the skis rose and control was excellent.

Other expected sensations were missing: the blind seesaw ride of most boats as they climb onto plane, the banging and lurching when running at speed on top of the water in even a moderate chop; directional instability and pitching when the hull takes waves at an angle.

I was captivated, watching the skis jounce furiously over the water while we felt only smooth motions in the boat. So, until Pensel asked, "Notice how dry it is?" it escaped me that we were being spared the affront of all speedboat rides—water in the face.

The first trials of the smaller model had confirmed the ski-hull idea. After making some refinements, Pensel built the 18-foot fiberglass model. This deeper hull is tippy at rest, so he boxed the skis and filled forward portions with foam, which helps to keep them at water level. For more lift he has added heavier springs and hull strakes.

On the water, we rode at 35 mph through an 18-inch chop as though on a highway, even though the seat cushions were a utility sort. Only occasional drops of water came into the cockpit.

Stability in turns is outstanding in both models. Control in turns is quick in the 12-footer but not in the 18, whose present steering gear is too light for the 160-hp drive. Actually, both hulls adapt continually to water and load conditions, as well as to maneuvering.

After these painless boat rides I'm not sure I wouldn't miss some of the rough-water experience of boating, a

Boxy shoulders on 35-degree hull support independent suspensions. Weight distribution aft keeps propeller in water.

Boat is easy to trailer on three supporting pads. Skis on 18-footer are 12-ft. long, set as far aft as possible.

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COLOR PHOTOS BY OZZIE SWEET

Ski hull's effectiveness in both 12- and 18-foot models indicates adaptability of the design. Left: Skis lift 18-footer high to reduce water friction and give a smooth and dry ride at high speed. Below, inventor Don Pensel shows trailing-arm suspension with Ford station-wagon springs and Monroe air shocks.

rigor that's exhilarating. But a hull you can use at full performance 100-percent more of the time is a major breakthrough. And I felt no fatigue, the big limiter in all-day cruising.

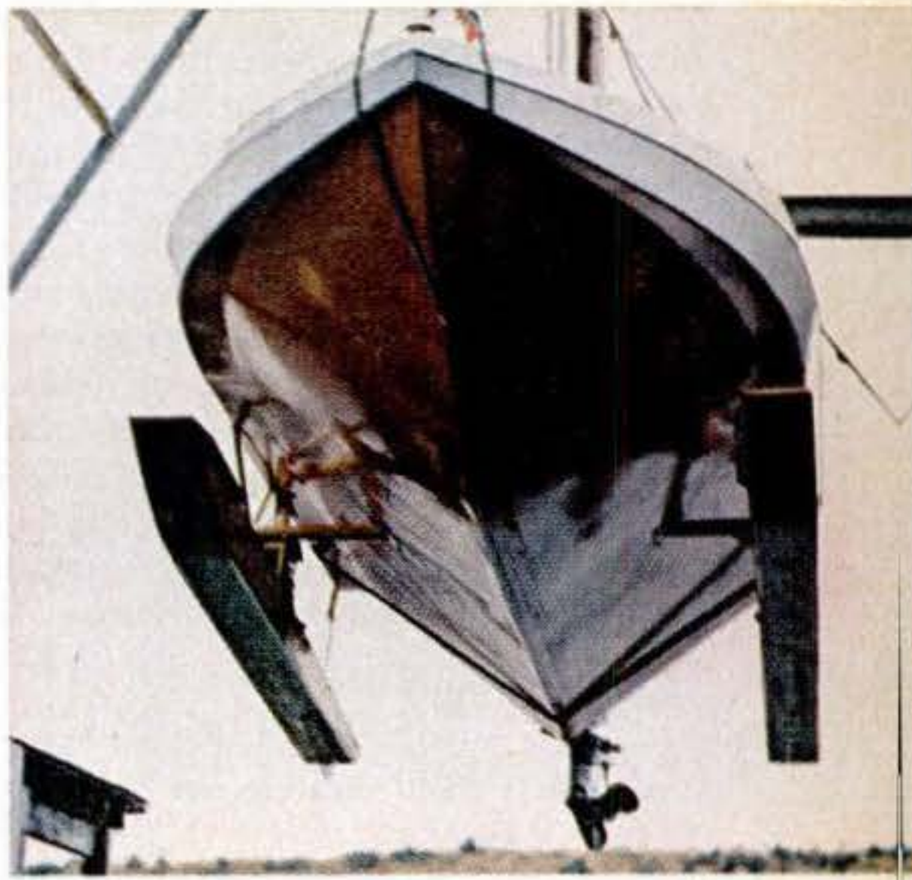
Further refinements

"Would you do anything differently if you had the chance?" I asked. "I would install the suspension system inside the hull with the arms projecting through," Pensel told me. Accordion rubber boots should keep the water out. It would make a better looking hull, with less corrosion to worry about. The skis could be retractable for ideal stability at rest; this would also enable making fine adjustments at high speeds for best performance.

"The hull would have a concave curve, ending horizontally at the chine. This would lower the boat's profile, increase lift on the hull, and reduce the draft. It would also make more cockpit space in a small boat.

The mechanical simplicity of the ski hull is disarming. Its design flexibility—for instance, in the position and width of the skis, and the shape of the hull bottom—practically eliminates restrictions. Big ski hulls, such as for military use, could take a lot of rough water at high speeds. For racing with a narrow hull, the skis might be projected outboard.

For sailing? Pensel thinks that wider skis, also spread out, would be needed to limit heeling. In light winds the skis could create a lot of drag; but an adjustment mechanism would fix that. PS



Cost of skis and suspension would be partly offset in production by lighter construction of hull bottom and frames.

Cuddy cabins

turn runabouts into mini-cruisers

There's room for two people —sometimes more—and lots of live-aboard comforts

By BOB BLACK

My, how you've grown! And in all the right places!

If you're on talking terms with a runabout boat with a so-called cuddy cabin, you might well say that. PS surveyed 28 of these craft, new for 1977. We found boats called overnighters, weekenders, convertibles, and vacationers. All are cuddy cabins, but roomier and more comfortable than their predecessors. If you remember when cuddies barely had space for some extra line, a spare anchor, a few tools, and a six-pack, today's models should pleasantly surprise you.

The reason for those expanded and refined cuddies? Many people want to cruise farther, and they want more of the comforts of home. But they don't want big cruisers at big prices, or gas guzzlers at any cost. For others, new fishing grounds beckon, but they may be a long, even wet, trip away—maybe an overnighter—and motels are expensive.

Today's cuddies reflect these needs. They sleep two (sometimes more) in comfort. A head is either optional or standard; often it's enclosed. Some cuddies sport a small galley. Virtually all have canvas to

Continued

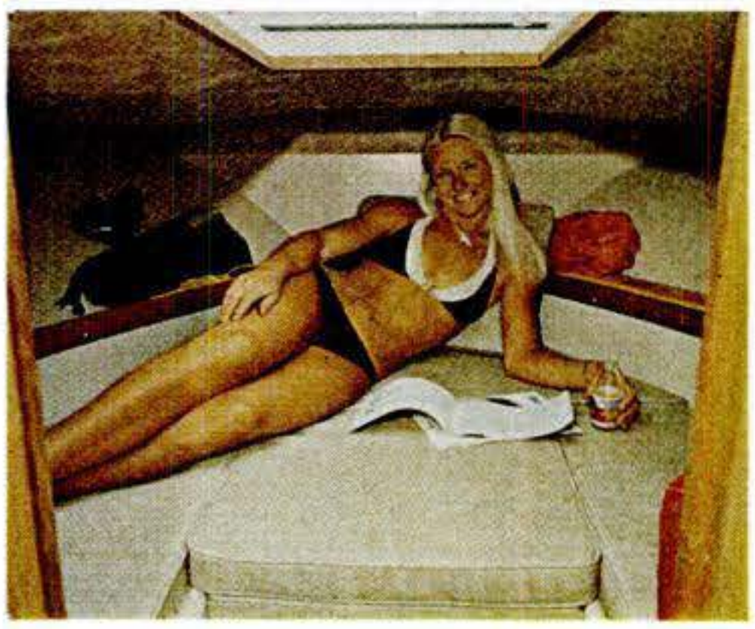
Wellcraft's 2000 Suncruiser sports an ingeniously placed two-burner stove just outside the cabin on the port side. When not in use, it's hidden. Other pluses: a forward hatch of smoked glass, an engine box that unfolds into teak table.

FLYBRIDGE STORAGE
HATCH
BENCH SEAT FOR TWO (STORAGE UNDER)
SEAT (STORAGE UNDER)
SINK (STORAGE UNDER)
CUSHIONED ENGINE BOX
V-BUNKS (HEAD UNDER)
SEAT (STORAGE UNDER)
COMPLETE GALLEY
STANDARD DIRECT-DRIVE CHRYSLER
40-GAL. FUEL TANKS (2)
MUFFLERS

Aquasport's first deep-V, the 246 can take 175- and 200-hp outboards, go 40 mph. There's a portable head, two 6¼-ft. berths, 70-sq.-ft. cockpit, and a teak platform between the berths for sleeping space or a fishing platform.

Luhrs 250 Sportfisherman has optional flybridge configuration, as cutaway shows. Galley includes built-in sink, 2.5-cu.-ft. icebox, space for two-burner alcohol stove. Two more economical models of the 250: the Sportsman and the Sportsman Deluxe.

Glastron/Carlson CV-23 is a fast-hull runabout with power—up to 460-cu.-in. Super Jet engine—and ease: a sun lounge and ski locker; luxury bar with 48-qt. chest; and cabin whose fur-lined ceiling allows sitting head room.



Grady-White 200 Dolphin (left) is an economically priced outboard with a good reputation. The stern-drive Grady-White 201 Marlin cabin (above) has vinyl-covered bunk cushions, shelves, under-bunk storage, nylon headliner.

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Starcraft Islander 22 is aluminum with lapstraking rolled into the hull for rigidity. Hull is guaranteed leakproof. Power options include either outboard or stern drive. Three different models are available.

Shamrock 20 fiberglass cuddy cabin has an "indestructible" full-length skeg keel, two 6½-foot bunks, full head room, and a marine head. The deck permits full walk-around for 360-degree fishing. Diesel engine is optional.

Thompson Vacationer 233 (shown with hardtop) is available with convertible or camper top. Cabin includes galley and dinette. Power options range from 170- to 255-hp OMC, MerCruiser, or Volvo. Head is optional.

Cobia C21CC Vantage is available with either outboard or stern-drive power options. She is a 21-foot deep-V cuddy with two full V-bunks; and doubles as an economy-priced cruiser, as so many of these boats do.

protect the cockpit and pilot's station in foul weather.

So what we have is a small cruiser on a runabout or fisherman hull. Most companies restrict beam to the trailerable eight feet. But Luhrs is nine feet four inches wide, AMF Slickcraft is a beamy nine feet eight, and Chris Craft's 25-foot Sportsman is an inch wider than that.

The walk-through windshield (the center folds away) is popular. Most of the craft have the steering station on the starboard side.

Fishing is not neglected. Aquasport's new 246, for example, sports over 70 square feet of open self-bailing cockpit in its 24½-foot length—more than on many larger boats.

The manufacturers have learned, to the future comfort of us all, that boat people have normal human proportions—they aren't midgets. Nor are they contortionists. The 246 has sitting head room over two 6¼-foot bunks. Some of these craft even have berths 6½ feet long.

Not surprisingly, cuddy prices differ considerably (see chart). Power is the big cost factor. Some are outboards, some inboards. The choices are wide and the costs (compared with those of larger cruisers) are reasonable. A year from now, it seems sure, there will be twice as many models. PS

Specs—what 28 cuddy-cabin boats are like

Model	Length	Beam	Max. hp	Price (F.O.B. plant)
1900 Offshore[1]	19'2"	7'10"	255	$ 9750 w/190 OMC
2000 Suncruiser[2]	19'5"	8'	235	9995 w/140 Merc
200 Dolphin[3]	19'8"	8'	215	5195 w/o power
201 Marlin[3]	19'8"	8'	235	9655 w/235 OMC
Shamrock 20[4]	20'	7'11"	215	11,500 w/215 14,700 w/diesel
Tiara 2000 Overniter[5]	20'2"	8'	250	10,800 w/188 Merc
206 & 206-C Beachcomber[6]	20'3"	7'9"	235	9624 w/170 Merc
204-C Hatteras Overniter[3]	20'4"	8'	230	5595 w/o power
205 Gulfstream[3]	20'4"	8'	235	10,555 w/235 OMC
Vacationer 233 Hardtop[7]	20'4"	8'	255	11,740 w/188 Merc
Fisherman II 7732 Hardtop[7]	20'4"	8'	255	9610 w/188 Merc
Majestic 206 Daycruiser[8]	20'6"	8'	300	9388 w/188 Merc
C21CC Vantage[9]	20'7"	7'6"	235	5385 w/o power
Cruiser or Camper F-4621[10]	21'2"	8'	175	9195 w/140 OMC
Islander 22 Mark IV OB[11]	21'4¾"	8'6"	165	4699 w/o power
Crusader 2255[12]	21'6"	9'5½"	Twin 170 Merc	15,825
Morrison 22 I/O[13]	22'3"	8'	235	12,349 w/235 OMC
Adventurer 253 Hardtop[7]	23'4"	8'	255	14,890 w/188 Merc
Explorer 7752[7]	23'4"	8'	255	11,915 w/188 Merc
Weekender 252[7]	23'4"	8'	255	12,340 w/188 Merc
CV-23[14]	23'4¾"	7'7½"	320IB	9649 w/320 V8
246 Deep V[15]	24'6"	8'	280	6795 w/o power
Tiara Vacationer 2500[5]	24'7"	8'	300	15,500 w/OMC 235
25 Sportsman[16]	25'	9'9"	Twin 130IB	16,985 w/twin 130's
L 250[17]	25'	9'4"	250IB	11,800 w/255 Chrys.
2576 Camper[18]	25'2"	8'	240	13,595 w/188 Merc
255 Suncruiser[2]	25'3"	8'	Twin 235	15,995 w/188 Merc
25 Convertible[19]	25'4"	9'8"	Twin 165	18,775 w/255 Merc

(1) **Fiberform,** PO Box 14647, Spokane WA 99214; (2) **Wellcraft Marine Corp.,** 8151 Bradenton Rd., Sarasota FL 33580; (3) **Grady-White Boats, Inc.,** PO Box 1527, Greenville NC 27834; (4) **Shamrock Marine, Inc.,** PO Box 1095, Cape Coral FL 33904; (5) **S2 Yachts, Inc.,** 725 E. 40th St., Holland MI 49423; (6) **Cruisers, Mirro Marine Div.,** 804 Pecor St., Oconto WI 54153; (7) **Thompson Boat Co.,** Peshtigo WI 54157; (8) **Regal Marine Industries,** Orlando FL 32809; (9) **Cobia Boat Co.,** Sanford FL 32771; (10) **Mirro Craft, Mirro Marine Div.,** 804 Pecor St., Oconto WI 54153; (11) **Starcraft Co.,** Goshen IN 46526; (12) **AMF Crestliner Div.,** 609 13th Ave. NE, Little Falls MN 56345; (13) **MFG Boat Co.,** 55 Fourth Ave., Union City PA 16438; (14) **Glastron/Carlson,** PO Box 9447, Austin TX 78766; (15) **Aquasport, Inc.,** 7925 W. Second Court, Hialeah FL 33014; (16) **Chris Craft,** 555 SW 12th Ave., Pompano Beach FL 33060; (17) **Luhrs,** Boundary Road, Marlboro NJ 07746; (18) **Carver Boat Co.,** Pulaski WI 54162; (19) **AMF Slickcraft Div.,** 500 East 32nd St., Holland MI 49423.

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How to get started in hot-rod sailing

Sol 18 flies one hull as its crew rides out on the trapeze (the harness attached to the mast) to balance the craft.

For sailors who want fast, high-performance thrills, here's a look at the new cats

By BEN KOCIVAR

The true hot rods of the sailing world are catamarans. They accelerate to speed in seconds, stop promptly on command, have a top speed two or more times that of comparably powered monohulls, and have the sensitive tiller response typical of nervous thoroughbreds.

Their skippers are invariably aggressive racers who eagerly grasp new techniques. The muscular demands of sailing hot cats eliminate anyone not in top physical condition. Any old salt who hangs around smugly proclaiming that "watching yacht racing is like watching grass grow" had best retreat to the club bar and the security of his cups.

But for the Walter Mittys of sailing, cats provide the ultimate platform for ocean exhibitionism, and on the cheap. America Cup 12-meter

Continued

Hobie 16 has kickup rudders (left) so it can ride up onto the beach. Fleet of fast, colorful Hobies (above) jockey for position at the start of a cat race.

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Tornado, first Olympic-class cat, can cost up to $7500 when custom-made.

Aqua Cat 12, with A-frame mast support, is easy to rig—ideal for beginners.

Bows on speedy Nacra 5.2 have fine leading edges that slice through waves.

Venture's asymmetrical hulls (like the Hobies') keep it from sliding sideways.

racers have a well-earned reputation for soaking up millions of dollars. But for anywhere from $900 to $7500 you can get a 12- to 20-foot-long catamaran that is not only a spectacular sailer but can also show its rooster-tail wake to the traditional greyhounds of the sea.

Have I convinced you that nothing that floats will give you more action or more fun per dollar of investment than a cat? If you're interested in doing some high-performance sailing, here's what you need to know—what makes the new cats hum, how to pick one that's right for you, and how much you'll need to spend to get into this exciting sport (also see chart, p. 111).

Light, twin-hulled craft

Today's fast cats are usually two slim fiberglass hulls connected by a plastic-fabric deck that looks like, and is called, a trampoline. Many early cat designs had fiberglass or wood decks. But the trampolines, reinforced with aluminum tubes, are now standard because they reduce weight and drag. These decks are usually porous, or have drain holes, so the crew is not stuck sitting in a floating puddle.

Sail plans are either a single tall, narrow mainsail or one with a jib. Cat sails differ from most in that they are usually fully battened—narrow strips of light wood or plastic are inserted horizontally across the sail. Battens not only keep the sail from flapping but also allow good shape control so the sail can make best use of the wind.

Because cats have a wider base than monohulls, they have greater stability and carry twice as much sail per pound as single-hull boats. It is this good power-to-weight ratio that is crucial for sailing at high speeds.

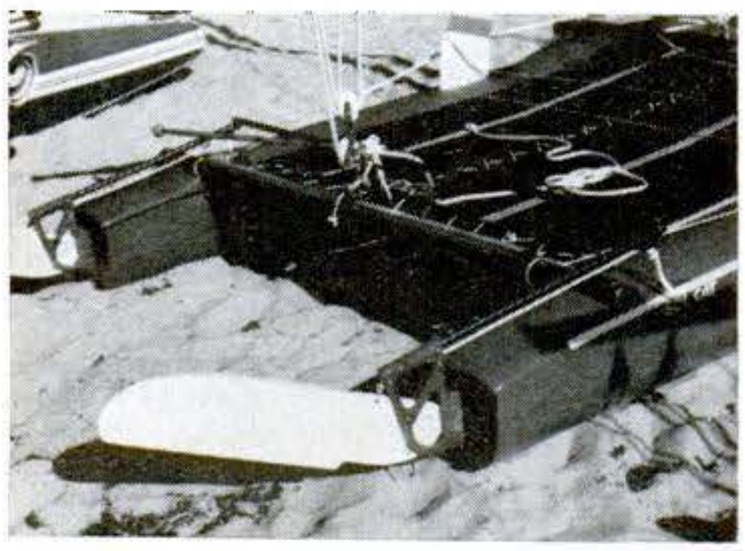
All new cats also have elliptically shaped, rotating masts. These act like the leading edge flaps on STOL airplanes, providing more lift and less disturbed air on the sail area directly behind the mast.

Picking the right cat

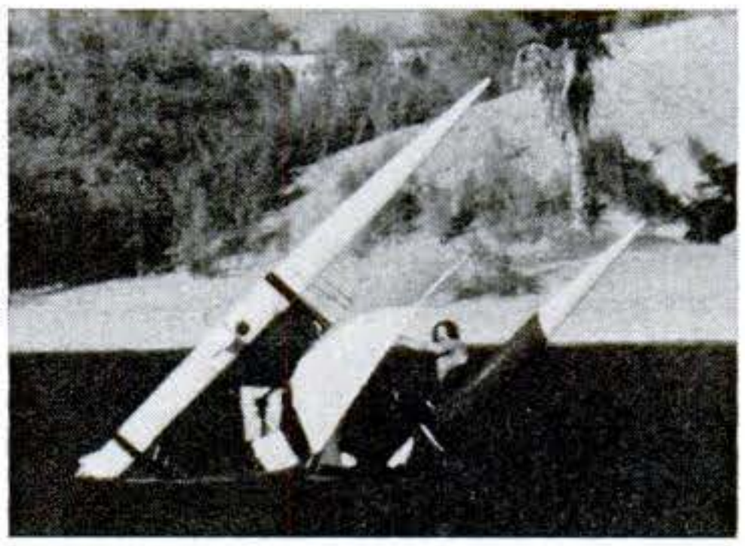
Most cat sailors like to race, and the kind of boat you buy may be determined by what makes and models are racing in your area. But cats can also race in mixed fleets with handicaps for each design.

Even small cats can carry as many as four people, but obviously, the more weight, the slower the boat will go. Day-sailing cats are usually optimally designed for one or two people. On the bigger boats, you usually need the weight of two bodies to hold the boat down in a good breeze.

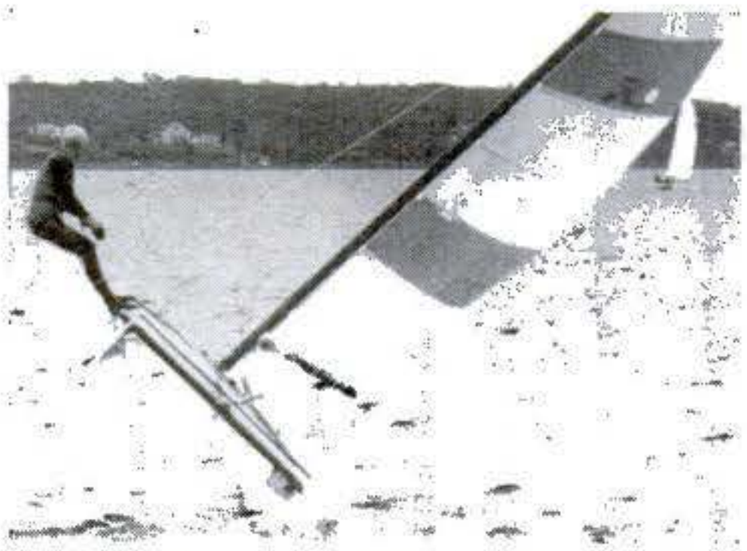
Besides size, there are some other elements that determine differences in the price tags of today's catamarans. Some designs use better, more expensive hardware. Others, such as the Tornados, cost more because they are true thoroughbreds, like Grand Prix auto racers—very light, fast, and sensitive. These have more



Rudders on all of today's cats flip up for shallow waters and beaching.



Cats still flip over, but new designs make it less likely. Boats right easily.



Not for beginners, flying high takes continual adjustments of tiller and sail.

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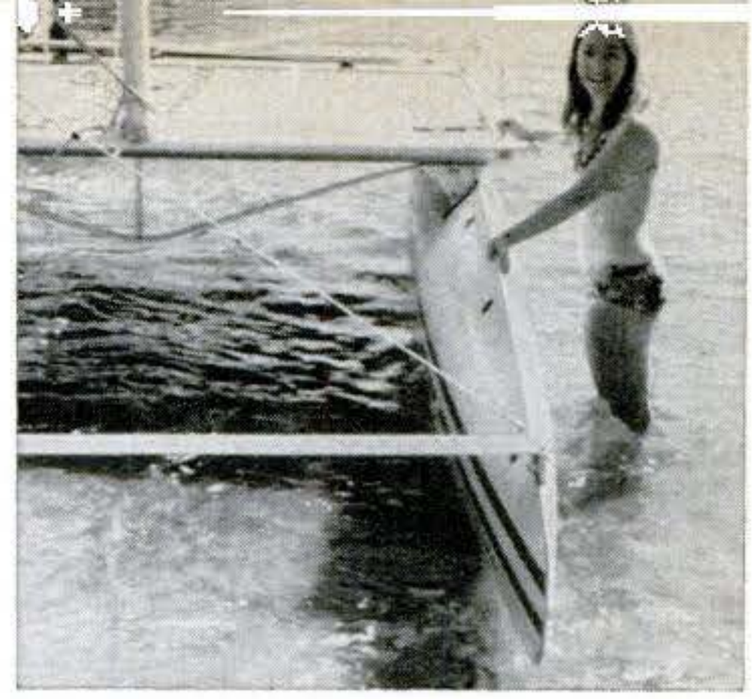
Prindle's extended controls let crew set tiller and sail for maximum speed—and perform a host of water-circus tricks, such as this balancing act.



Sizzler's finely tapered aluminum hulls keep sharp edge deep in the water.

handwork, and most are custom-made.

Some, like the Hobie line, are quite rugged. Though the newest Hobies are the same basic design as the original versions, the company has made continuous improvements over the years in fittings and materials.

How today's cats are better

There are several basic differences in design that make current catamarans faster and better than those of ten years ago. The beam formerly used to connect the bows has been eliminated in most designs, leaving only two tubes connecting the hulls at the center and the stern. The forebeam's purpose was to keep the bows from twisting or pulling together under stress. But this beam would often be caught by waves when the boat was driven hard. The sudden drag would not only slow the boat but could also cause it to flip over or pitchpole. It was a wild sight. The abrupt drag would suddenly "trip" the hull and whip the entire craft and crew forward into the water.

Pitchpoling was also caused by the short, wide bows on older cats, which were flared for reserve flotation. When wind pressure on the sail pushed the leeward hull deep into the water, the sudden drag often flipped the whole boat.

The advanced design of new cats makes pitchpoling less likely. The treacherous forebeam is gone, and the new hulls have been engineered stronger to resist twisting under stress. Some models, such as the Nacra 5.2 and the Alpha 18, are also designed to allow some flexibility without damage. The newest hull designs, on the Sols and Nacras, for example, are slimmer and extend farther forward ahead of the mast. The extra length forward provides more buoyancy to resist pitchpoling.

Many designs also feature daggerboards inserted through slots in the center of each hull. Shaped like an airplane's wing, these long thin daggers make for faster boats. They provide more resistance against slipping sideways and also enable cats to point up higher into the wind.

Rudders of the newest designs are also shaped like airplane wings, since flat surfaces create turbulence and drag at high speeds.

The Hobie cats and some others have no daggers, but have asymmetrical hulls. These are relatively flat on on the outside and curved like a wing on the inner surface. When the leeward hull digs into the water, it gives lift to windward, like a wing set on its side. This keeps the windward hull, lifted high out of the water, from pulling toward the leeward side.

The ancient Polynesian cats had asymmetrical hulls. So do the big beach cats used in Hawaii today, which sail across reefs and sand bars to ride up on the beach.

These hulls are not as easily damaged in shallow or rocky water, and are easier to sail. No daggers means they're easier to construct, so they also cost less.

They can't point up into the wind as well as daggerboard cats, however, and they are not quite as fast. All sailing speed records are held by cats with symmetrical hulls and daggerboards. Though the Hobies are still the most popular boats, there is a definite trend toward use of daggerboards. Even the new Hobie 18 will have them.

The joys of cat-sailing

Cats are a showoff's delight. I must admit that I often casually maneuver my 18-foot Alpha cat abreast of some monstrous 40- or 50-gold-plate yawl that is shoving its way through Long Island Sound, powered by 1200 or more square feet of expensive sail. Glass in hand, her crew will deign to stare down at our sea-drenched trampoline deck. We return the kindly waves of one "yachtsman" to another Then, a quick yank on the sheets of my 235 square feet of sail flattens the sails and with my toes on the tiller we streak by. The lee bow shoots water at us like a fire hose. Our daggers and rudders start humming like miniature jet engines as we sail in tight at right angles to the wind and create enough speed to beat the wind.

It's hardly fair competition. Even the least expensive of modern small daysailing cats get up over 15 knots. The better 18- and 20-footers get over 21. Meanwhile, the giant "lead mines," shoving heavy keels through tons of water, are limited to speeds

[Continued on page 150]

Buyer's guide to catamarans

Model	Length	Beam	Sail Area (sq. ft.)	Weight (lb.)	Price
Aqua Cat 12[1]	12′2″	6½′	90	165	$1095
Aqua II 14[1]	14′4″	6′6″	110	195	1395
Banana 5.5[2]	17′6″	7′11″	200	335	1995
Carib 18[3]	18′	7′11″	225	340	2330
Cheshire[4]	14′	6′6″	135	185	1750
G-Cat[5]	16′4″	7′11″	210	315	2500
Hobie Cat 3.5[6]	11′6″	6′	66	160	1149
Hobie Cat 14[6]	14′	7′8″	118	225	1590
Hobie Cat 16[6]	16′7″	7′11″	218	340	2095
Isotope[4]	16′	7′6″	185	255	2300
Nacra 5.2[7]	17′	8′	194	325	2950
Alpha 18[7]	18′	10′	244	350	3250
Alpha 18 sq. meter[7]	17′	10′	194	360	3000
Prindle 16[8]	16′	7′11″	190	310	2195
Sea Spray 15[9]	15′	6′5″	150	125	1595
Seafire Sizzler 18[10]	18′10″	8′	260	400	3195
Sol Cat 15[11]	15′6″	7′11″	160	275	1845
Sol Cat 18[11]	18′3″	7′11″	220	333	2295
Tornado 20[12]	20′	10′	235	300	4000 to 7500
Venture 15[13]	14′9″	7′6″	167	250	895

[1]**American Sail, Inc.,** 10 Pringle St., Stark Industrial Park, Charleston SC 29405; [2]**Seareed Products, Inc.,** 17391 Murphy Ave., Irvine CA 92714; [3]**Carib Catamaran Corp.,** 232 Carswell Ave., Daytona Beach FL 32017; [4]**Fiberglass Unlimited,** 2212 S. Miami Blvd., Durham NC 27703; [5]**G-Cat,** 11407 Seminole Blvd., Largo FL 33540; [6]**Coast Catamaran,** 2026 McGaw Ave., P.O. Box C-15909, Irvine CA 92713; [7]**North American Catamaran Racing Association,** 214 E. Montecito St., Santa Barbara CA 93101; [8]**Surfglas, Inc.,** 1810 E. Borchard Ave., Santa Ana CA 92705; [9]**Glenmore Boats, Inc.,** 1800 E. Borchard Ave., Santa Ana CA 92705; [10]**Great Lakes Sports Mfg., Inc.,** 5135 Richmond Rd., Cleveland OH 44146; [11]**Sol Catamarans, Inc.,** 1932 E. Pomona St., Santa Ana CA 92705; [12]Made under license by: **R.J. Hawley,** 12015¾ Venice Blvd., Los Angeles CA 90066; **Sail Craft Ltd.,** Waterside, Brightlingsea, Essex, England; and others; [13]**MacGregor Yacht Corp.,** 1631 Placentia, Costa Mesa CA 92627.

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New fishing gear

engineered to hook more big ones

Angler's choice—take your pick of the latest from the tackle makers

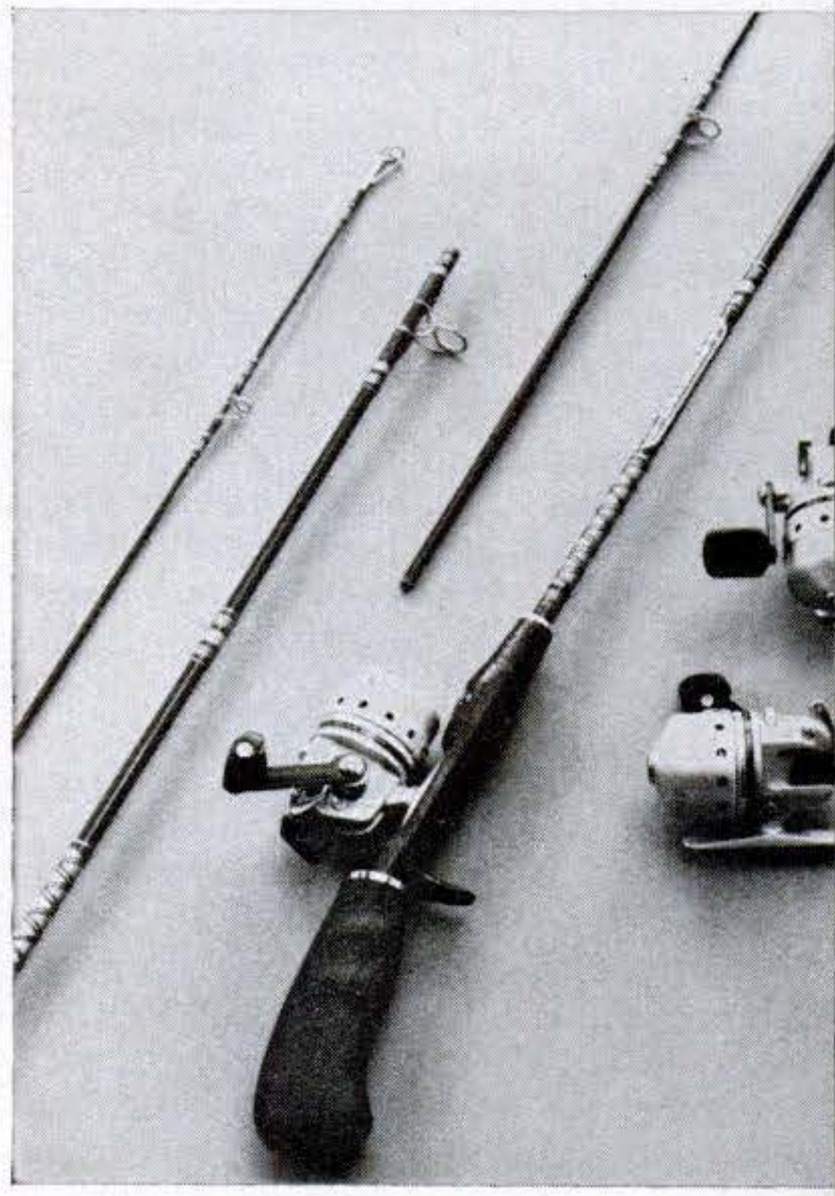
By A. J. HAND

Fishermen are hard to please. No matter how full the stringer, to the angler's mind there's always room for more—and bigger—fish. The killer lure, the line that never breaks, the reel that never throws a bird's nest, the rod that casts a country mile . . . The fisherman is always looking for the ultimate in fishing gear.

Tackle makers may never achieve the ideal, but they are getting closer every year. Take lines, for example. You'll see more Teflon-coated lines this year. Gladding has put the slippery plastic on its new fly line, and Gudebrod has it on a new braided casting and trolling line. With Teflon, you get less line/guide friction; your line should last longer and cast farther.

Bright colors are showing up in fly lines, too. Some years back, DuPont suggested that bright lines are easier to see and control, and introduced fluorescent Stren monofilament. Now fly casters can get the same benefits with Orvis' Strike Indicator lines, which have a bright-orange tip section, and Cortland Hot Yellow 333 lines, which are yellow from end to end.

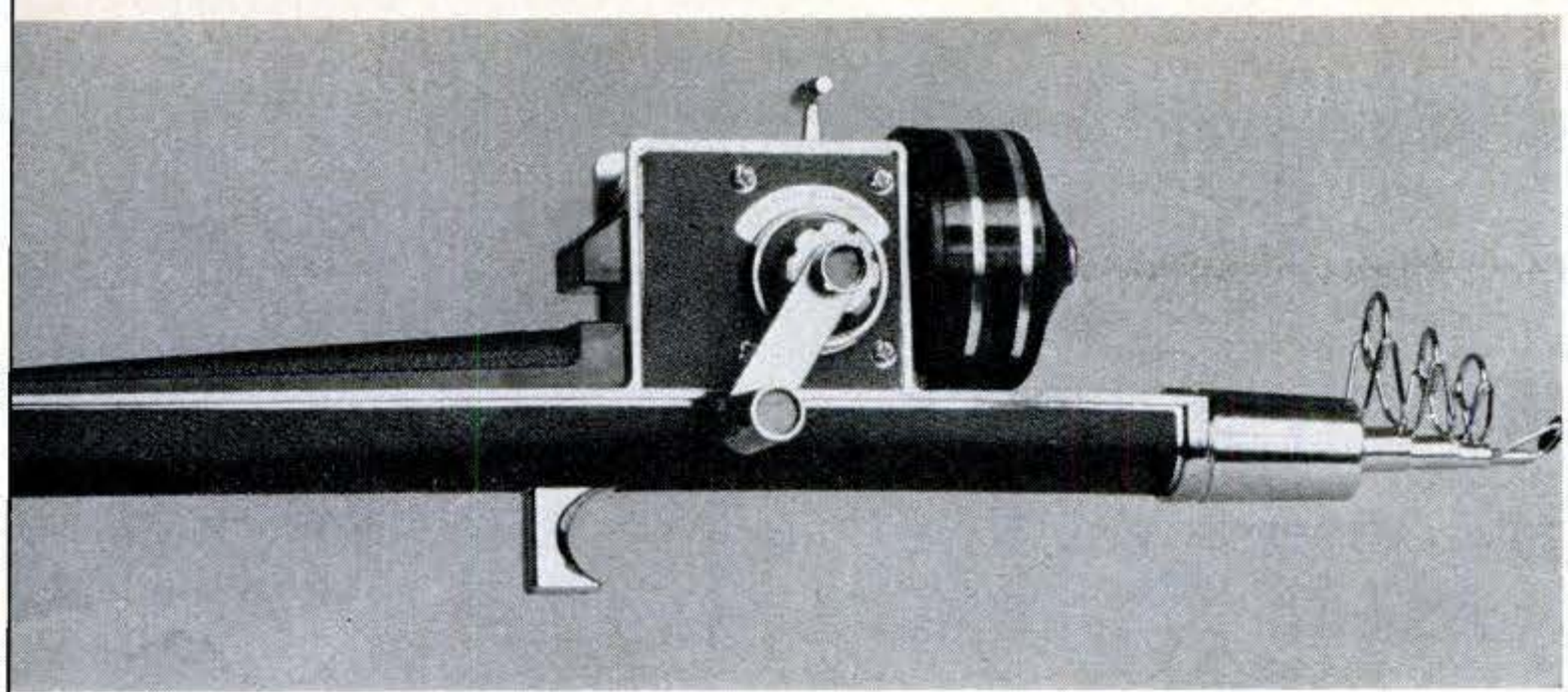
But lines are just the beginning of the story. Take a look at some of the new offerings in lures, rods, and reels shown on these pages. There might be something here to increase your chances of a big catch. PS

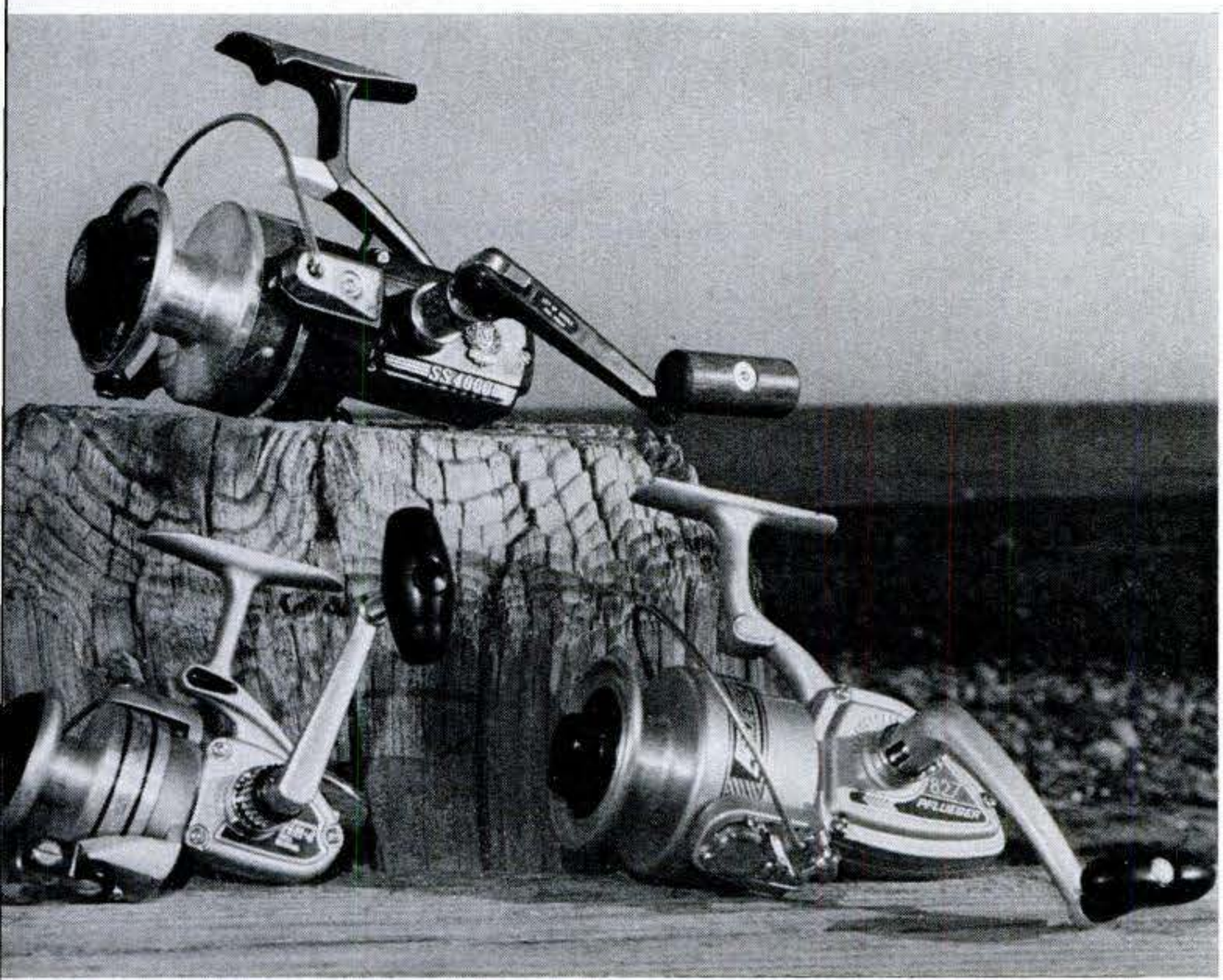


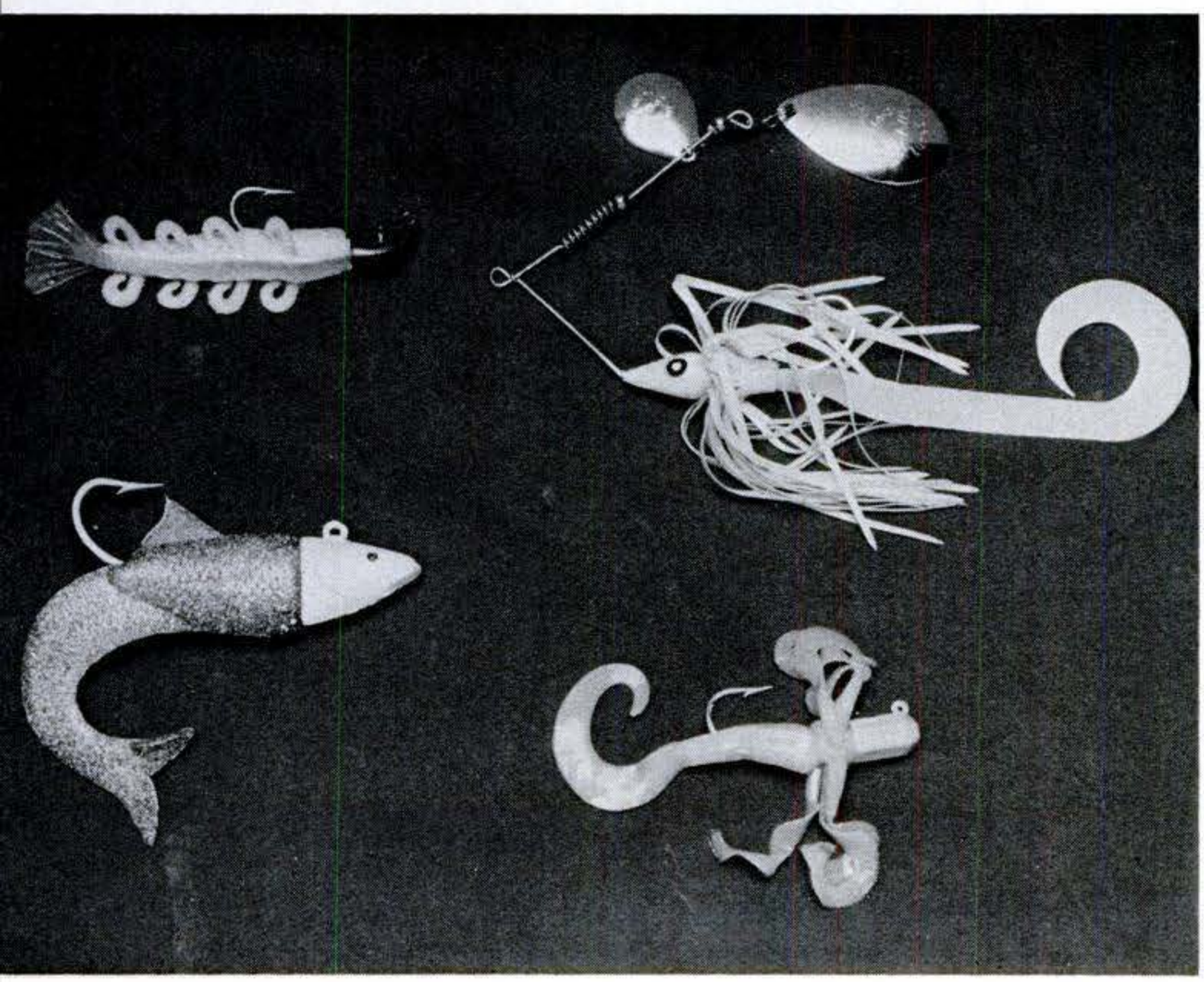
Ultralight spin-casting reels have arrived. Three examples are Eagle Claw's Microcast (above), Daiwa's Minicast reel and rod set (upper right), and the Heddon Ultra-Cast (right). The Zebco 113 (not shown) is another ultra-light that's new this year. All these little mills weigh about five ounces, about half the weight of the typical spin-cast reel.

All are ideal for the angler on the go. The Daiwa Minicast reel and rod, for example, will fit into a special plastic case just over 15 inches long. The whole outfit weighs less than 20 ounces and is great for anglers backpacking to wilderness waters.

Casting reels? Biggest news: two new Ambassadeurs from Garcia. Each has "Thumbar," which lets you put the reel into free spool with your thumb as it rests in casting position, right on top of the line.







Telescoping rods and poles are getting a big play this year. At left is the St. Croix Fishing Machine with built-in reel. Johnson also offers telescoping poles with built-in reels. Makers of telescoping rods include Childre, Heddon, Trimarc, Alliance, Kodiak, Plasteel, B&M, and Stillfish. Another trend: Expect to see more graphite in high-quality rods, for every fishing style from ultralight to 130-pound-class trolling. Graphite pioneers such as Fenwick and Shakespeare have been joined by Eagle Claw, Berkley, Skyline, Hardy, Scientific Anglers, Quick, Pflueger, and others. Some makers are building hybrid rods with graphite in the butts and glass (Shakespeare Ugly Stik) or polyester in the tip section (Childre's Super Speed Stick). Build your own rods? Look for graphite blanks from 3M, Graftek Exxon, Fisher; and Lamiglass, which now offers a total of 64 different graphite blanks.

Skirted spools are the big news in spinning reels. The three at left are: the big Daiwa SS 4000 (top) with silent anti-reverse; a tiny HM-4 (left) from Olympic, and the 827 (right) from Pflueger's new 800 series. Japanese makers—first Daiwa, then Olympic—started this trend. Now skirted-spool reels are available from American manufacturers, including Pflueger, Shakespeare, Quick, Wright McGill, and others. (Most import the spools from Japan.) The advantages? No more line foul-ups behind the spool, reduced line wear, longer casts, greater line capacity. There's even a trend within a trend: automatic or internal bail trips. Most skirted-spool reels close the bail by means of a plastic "knocker" on the reel seat support (note the white protrusion on the Daiwa). This is a foolproof mechanism, and it lets you close the bail by hand. But it's clumsy and noisy. Quick and Wright McGill close the bail with an internal mechanism like the type used in conventional spinning reels.

New curly-tail lures are (clockwise from upper left) Mister Twister Sassy Shrimp, Cordell's Spring Killer, Paducah's Jig N'Eel, and Burke's saltwater Magnum Minno. The life-like swimming action of these soft-bodied plastic lures appeals to fish and fishermen alike. But easy-to-fish crank baits (no jiggling necessary) are still the most popular lures. New this year: Heddon's deep-diving Hedd Hunter with a hydronic hole in the lip; water flowing through the hole creates sound waves said to attract fish. An extra large lip on Bomber's new deep-diving Model A sends it down to the deep holes where bass spend the hot summer months. Tubby Tackle offers Tiny Tubby, an ultralight deep-diver with interchangeable curly tails. Other innovations: the Difference, a spinner with wooden blades that float the lure free of underwater obstructions, from H & H Lures; and Aquasonic Lures' Lil' Noisy, a plug with a maze of channels that create sound waves as the lure moves.

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A new slant for **paneled walls**

PHOTO BY THE AUTHOR

Tongue-and-groove western red cedar—installed "reverse" side out for clean lines—transforms wall of living room. I left cedar unfinished, enhanced wood grain with spotlights. Framed, stuffed figure by Ellen Rixford.

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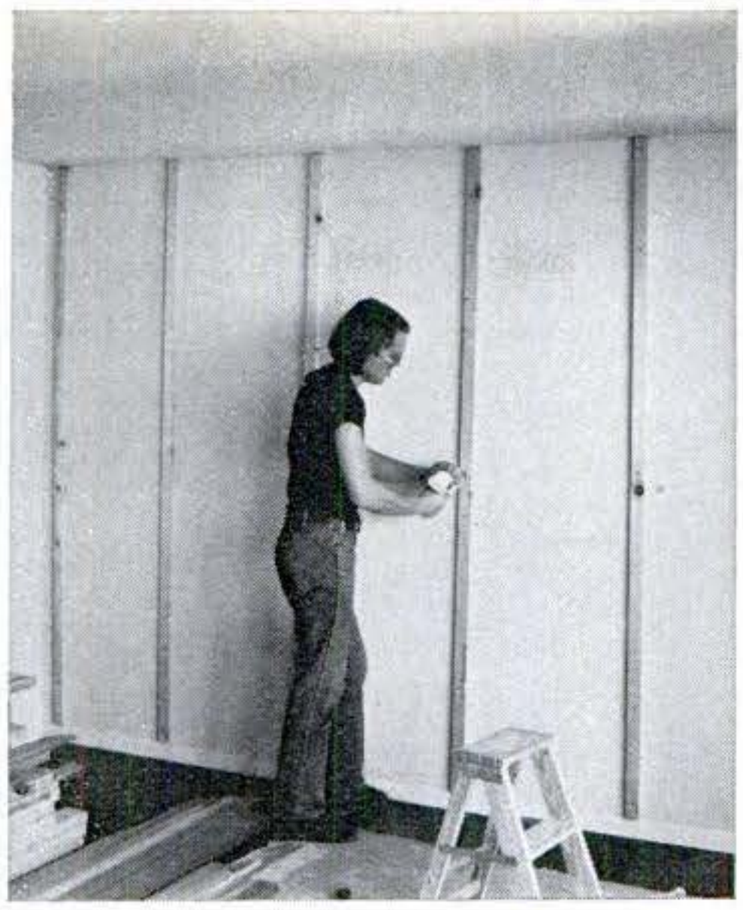
Banish the bland look by strip-paneling an accent wall at 45 degrees

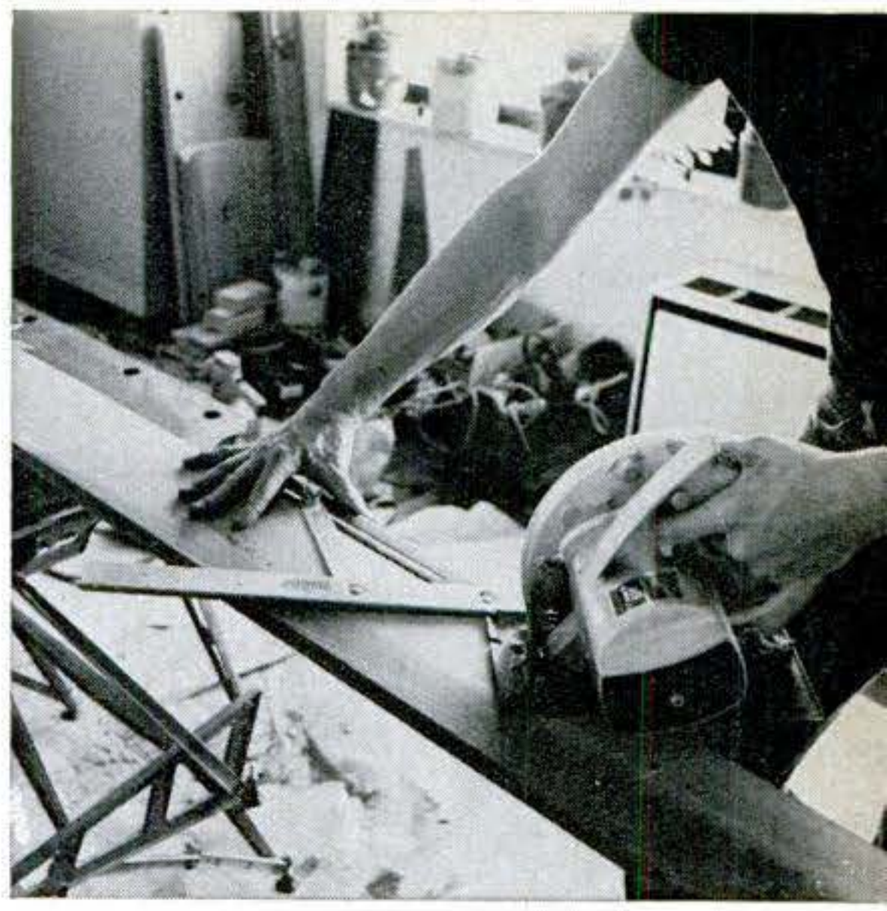
By RICHARD STEPLER

Paneling one prominent wall in a room can be a more effective—and much less expensive home-decorating project—than paneling all four. And applying the paneling—here, 1-by-6 tongue-and-groove western red cedar—at 45 degrees gives special impact to this accent wall.

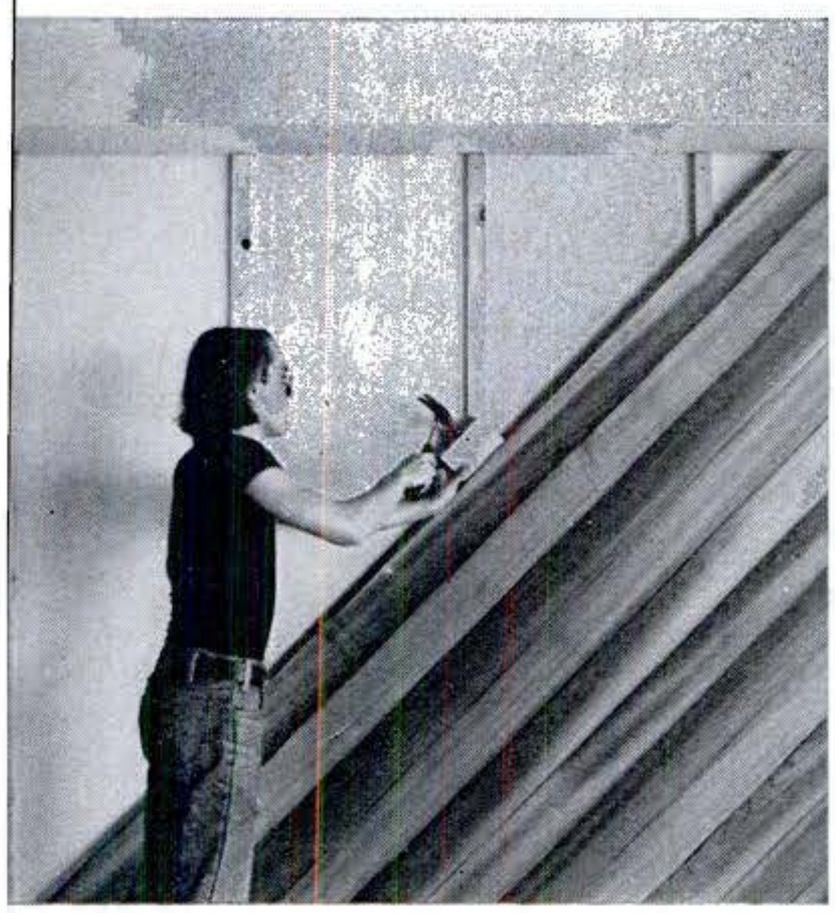
While I used plastic anchors to attach the furring because there wasn't space behind the dry-wall for toggle bolts (see drawing), I'd recommend the latter if you've got clearance. Either way, if you move—or change your decorating scheme—it's easy to remove the paneling.



1 Cordless drill/screwdriver (Skil's model 2002) makes quick work of putting up 1-by-2 furring strips. If wall is uneven, shim strips so they're level.

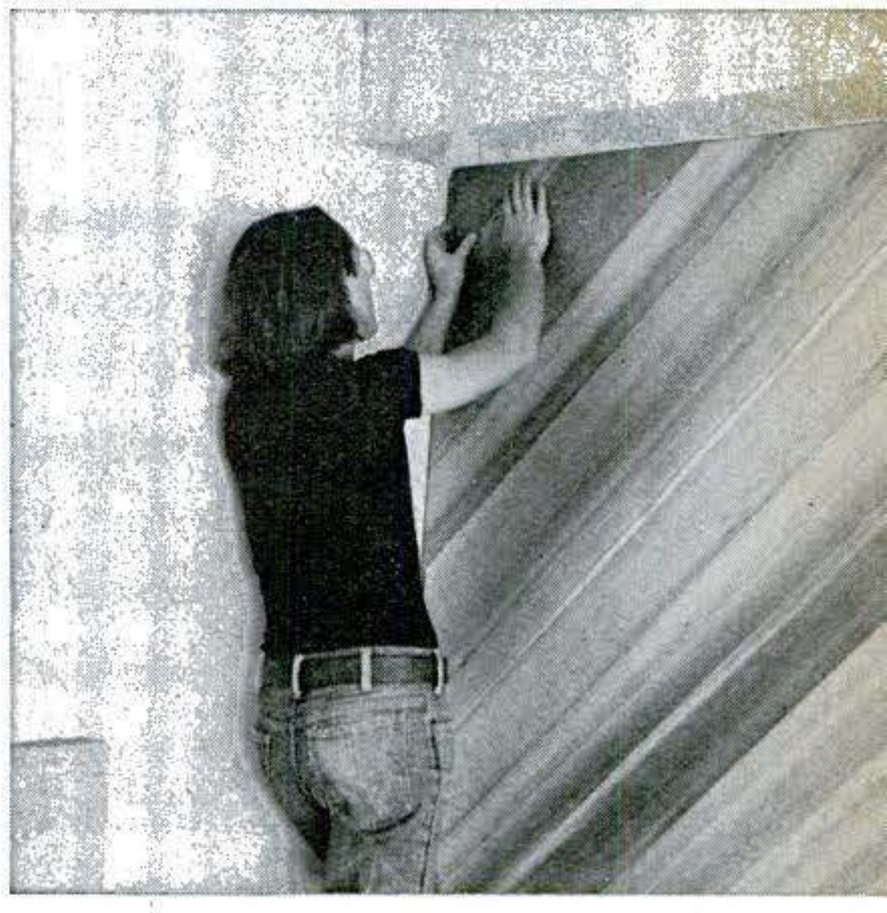


2 Angle-cutting guide saved time, assured accurate cuts. I set it once at 45°, cut boards to length as shown in the drawing below.

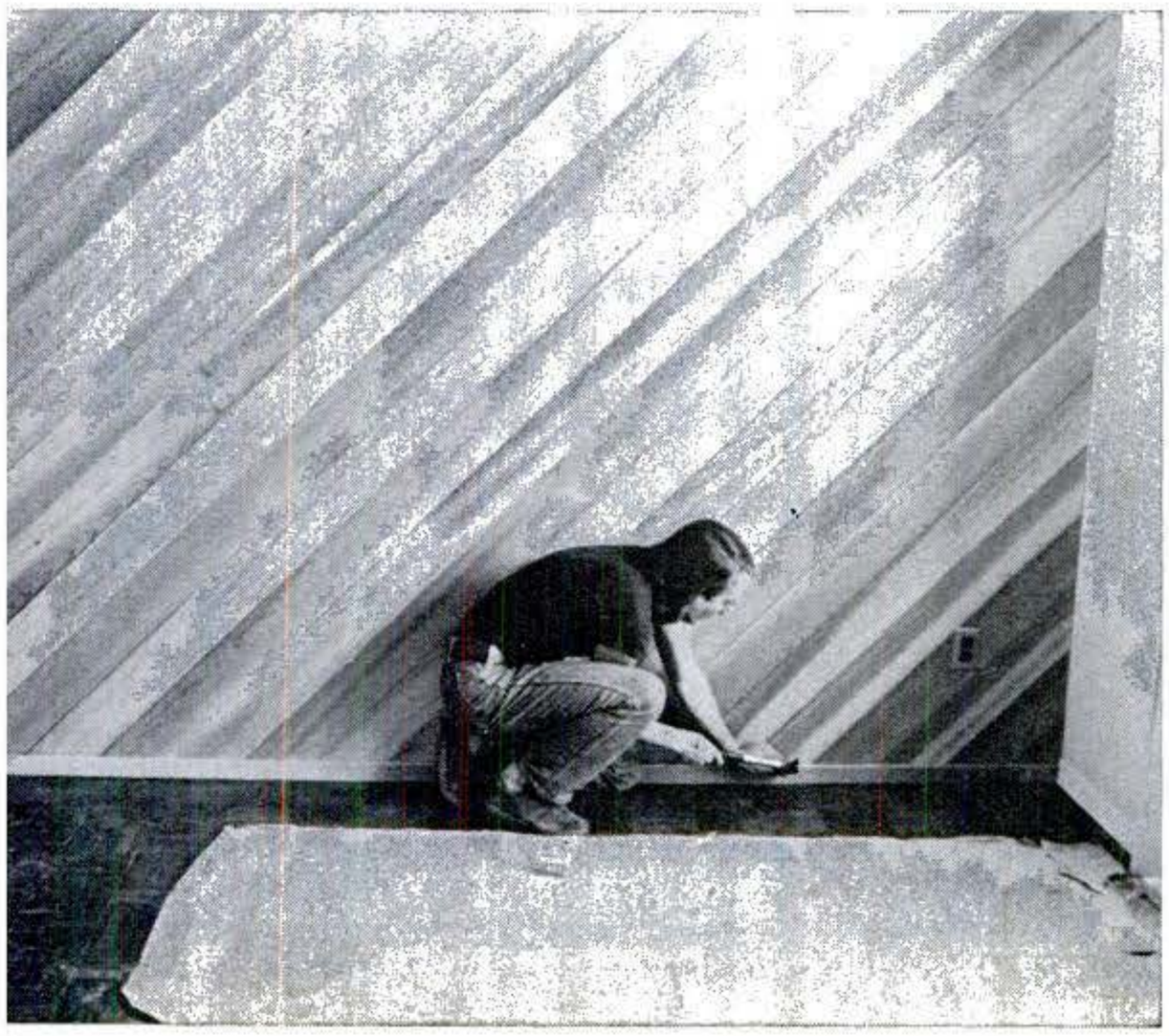


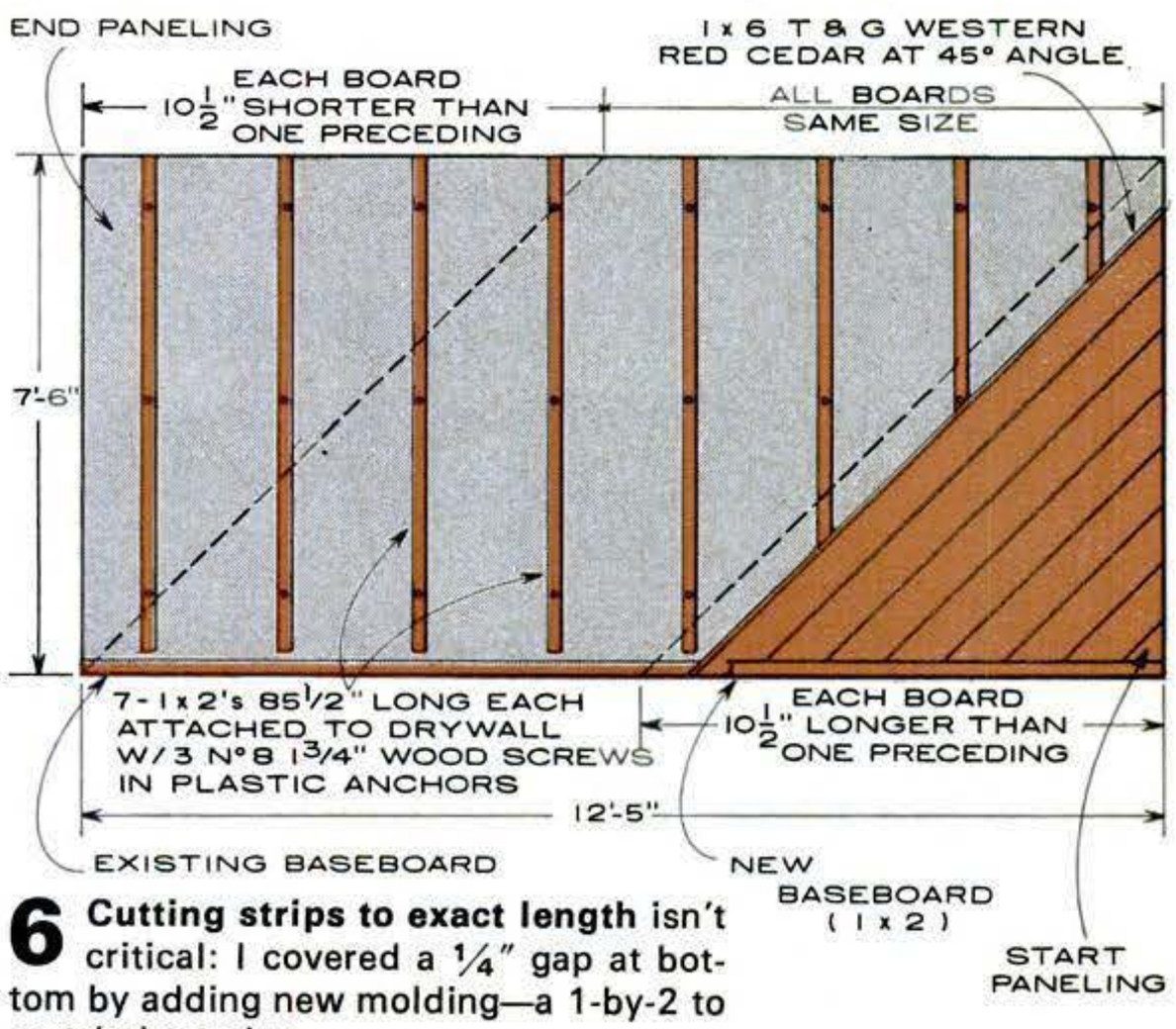
3 After cutting each strip to length, I fitted it into place by hand. Then, using a scrap of wood to protect tongue, I tapped each joint tight.

4 I nailed each strip through the tongue to furring strips, using a nail-set to protect the cedar's surface. The next strip will hide the nail heads.



5 Last piece—a tiny, slice-of-pie-shaped wedge—simply slips into place in upper left-hand corner of wall. Molding along left side secures it.





6 Cutting strips to exact length isn't critical: I covered a ¼" gap at bottom by adding new molding—a 1-by-2 to match the cedar.

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You can make space to install a dishwasher

An island for a portable

A peninsula for a built-in

Built-in dishwasher's peninsula addition to an existing counter (left) also holds a handy pullout rolling cart (shown above) for convenient, portable storage of dishes, other tableware.

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If your kitchen's geography doesn't offer a site for this labor saver, create one of these alternatives

By RICHARD STEPLER

These unique installations offer not only a place for a dishwasher in a cramped kitchen, but generous storage space as well. And what better place to stow dishes, pots, pans, and tableware but right next to the machine that keeps them clean?

- The island, intended as home for a portable dishwasher, has generous double-access storage behind the machine.
- The peninsula, made for a built-in dishwasher unit, offers a clever rolling cart that can travel from kitchen to dining table, or out to the patio when you're picnicking. Slipped into its spot next to the dishwasher, it blends with existing cabinets.

In the kitchen/dining area shown, the peninsula takes up the space of one regular base-cabinet unit. At right angles to the existing counter, it's located near the sink. It also divides the kitchen work area from the adjacent dining area.

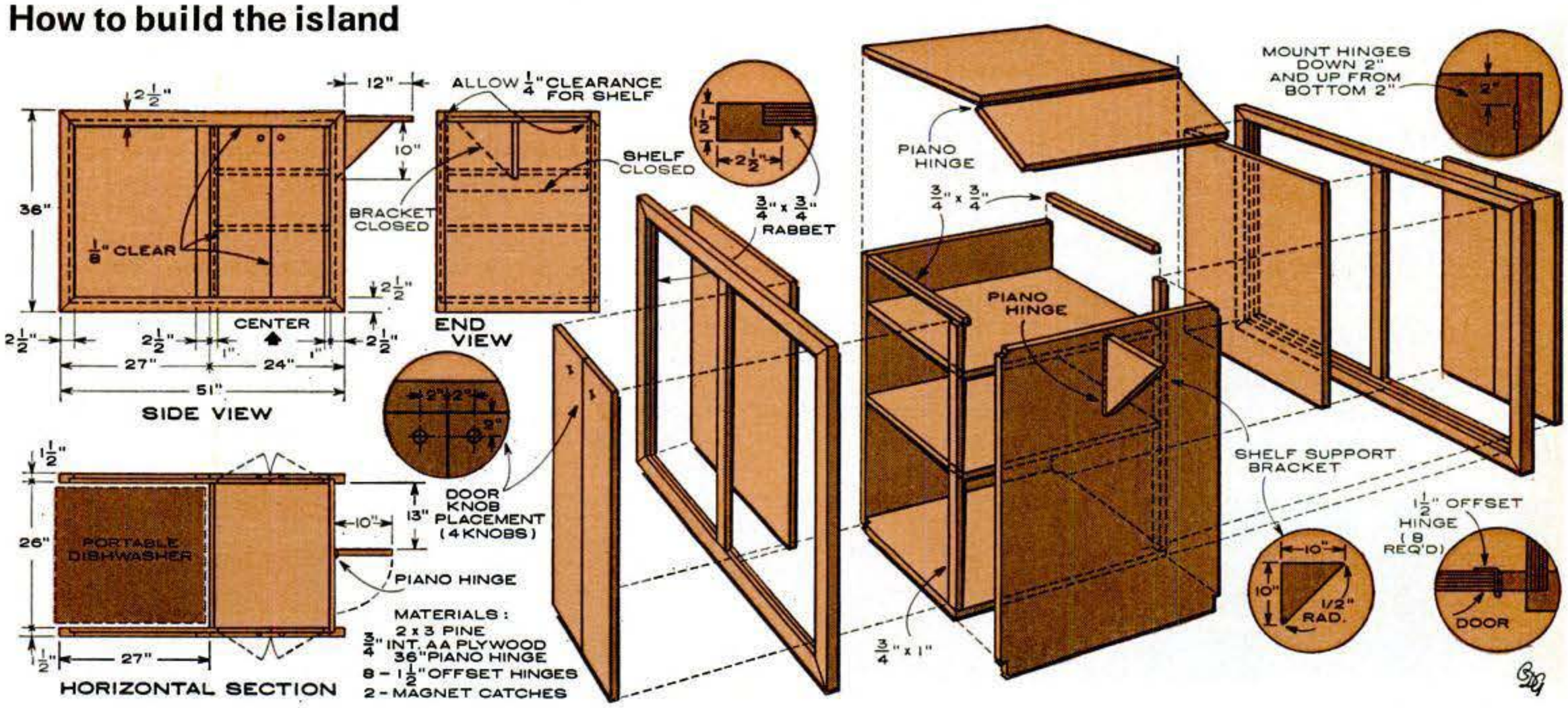
The island takes advantage of this portable dishwasher's cutting-board top. You can locate it anywhere there's floor space: centered in the kitchen work area, or even positioned against a wall. (In the latter case, you'd eliminate one set of cabinet doors.) The unit's fold-down shelf gives you a quick spot for snacking, menu planning, or food preparation.

The drawings below give detailed dimensions and show the materials needed. Note that dimensions shown will accommodate Maytag's model WU601 built-in dishwasher (for the peninsula) and model WC401 portable (for the island). Alter the dimensions to suit other makes and models.

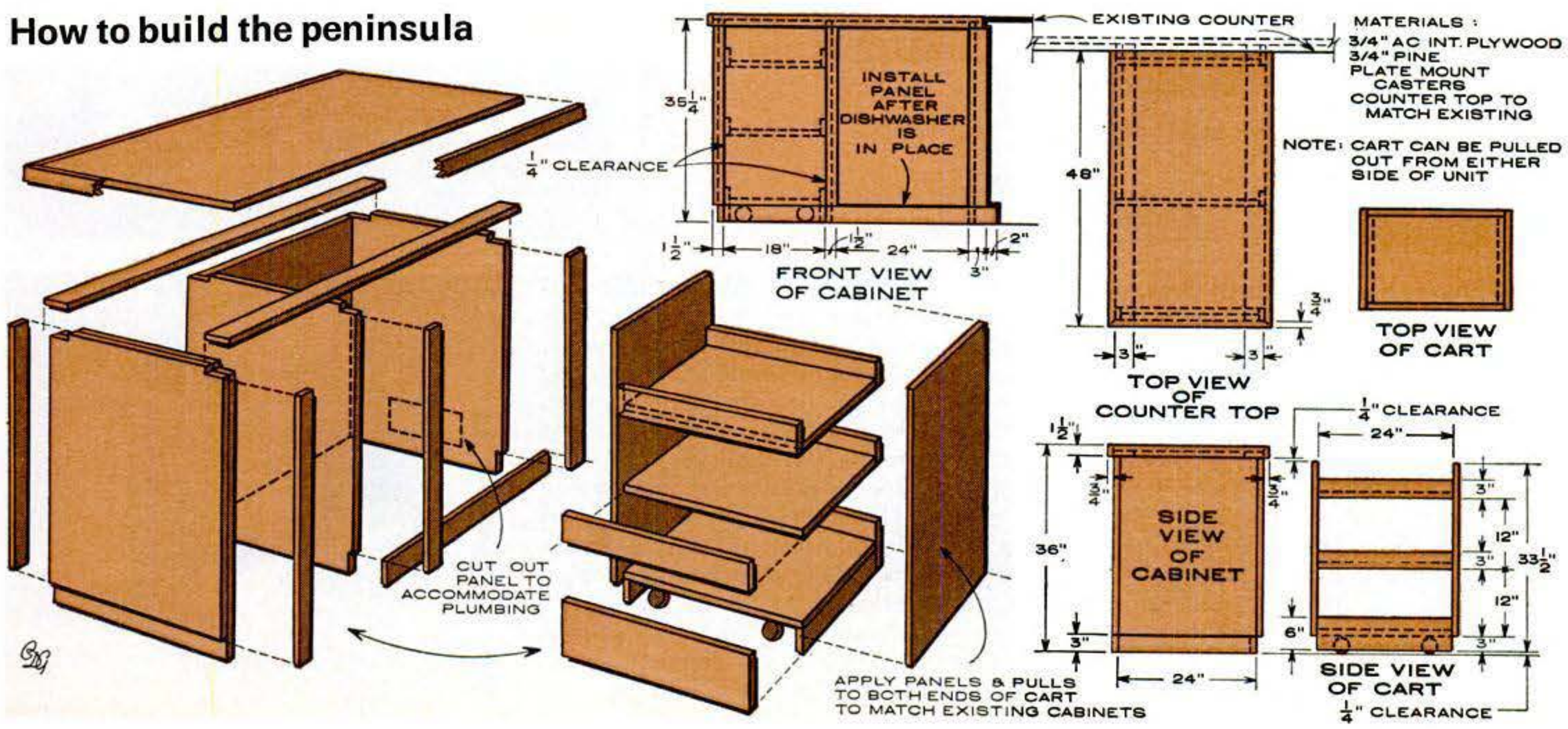
Want further information? Installing the built-in dishwasher will be easier if you first read a 36-page booklet that's 25 cents from Maytag (Newton, Iowa 50208). It describes utility requirements, how to provide drainage, and how to cut and fit tubing. PS

Island location needs no plumbing hookup: Dishwasher is portable and wheels to sink for connection. Island also offers double-access storage cabinet, plus a sturdy fold-out shelf for extra serving space.

How to build the island



How to build the peninsula



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Sharpening secrets of a pro

You can get a razor edge on all of your tools and knives by following these simple steps

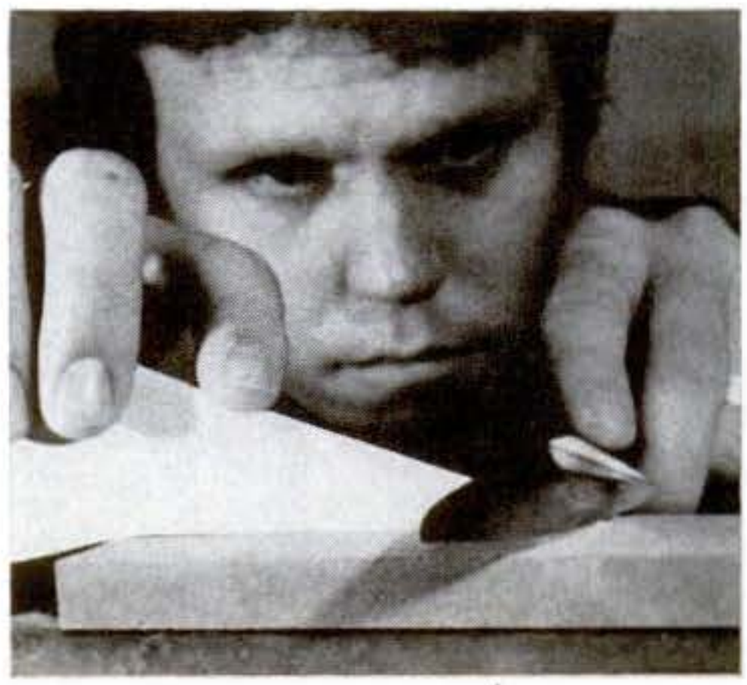
By JOHN A. JURANITCH

John Juranitch got interested in sharp edges as a barber in the Korean war. Later he began a full-time study of blade design and composition, abrasives, honing, steeling, and other subjects related to blades and sharpening. Today, he runs a business called Razor Edge Systems in Ely, Minn.

"The real expert we have to please is the meat cutter," says Juranitch. "You find a man who has pulled a blade 10 hours a day for the last 20 years. He has no Ph.D., but he will tell you if a blade is sharp. All he has to do is bury it about six inches in cold beef and pull . . . Many times when we're working a blade, we will notice blood. But we have to hunt for the cut, because a sharp edge produces a painless cut."

Despite all the misunderstandings and misinformation that produce so many improper sharpening methods, Juranitch claims that getting a nearly perfect edge isn't difficult—if you understand the principles and follow a few simple rules. Read on to learn the sharpening secrets of a pro.

How to sharpen a knife: Keep your hone from moving by putting it on a soft piece of rubber or tacking small pieces of wood around it. Use a Razor Edge guide (photo above) to establish the proper angles for primary and secondary edges, or try this trick: Fold one 90-degree corner of a piece of paper in half. Fold in half again, and you have 22.5 degrees. Hold the blade at this angle or slightly less for your *primary*-edge face (right). Fold the paper again and you get 11 degrees. This is the angle you should use with the *coarse* hone for the secondary edge. Use whichever motion you prefer, back and forth or circular, being very careful to hold the angle constant. If you have trouble knowing when the burr forms (see diagram next page), check with a magnifying glass; once you *see* that curl you'll learn to feel it with your fingernail. When you go to the fine hone to form the primary edge, stroke the knife *into* the hone as if you were trying to slice it. Use only light pressure, as the edge is microscopic and pressure will distort it. Make alternate strokes on opposite sides of the blade. When the edge will shave hairs from your arm, it is usable. If you wish, concentrate on one section of blade at a time, leaving the curved tip until last.



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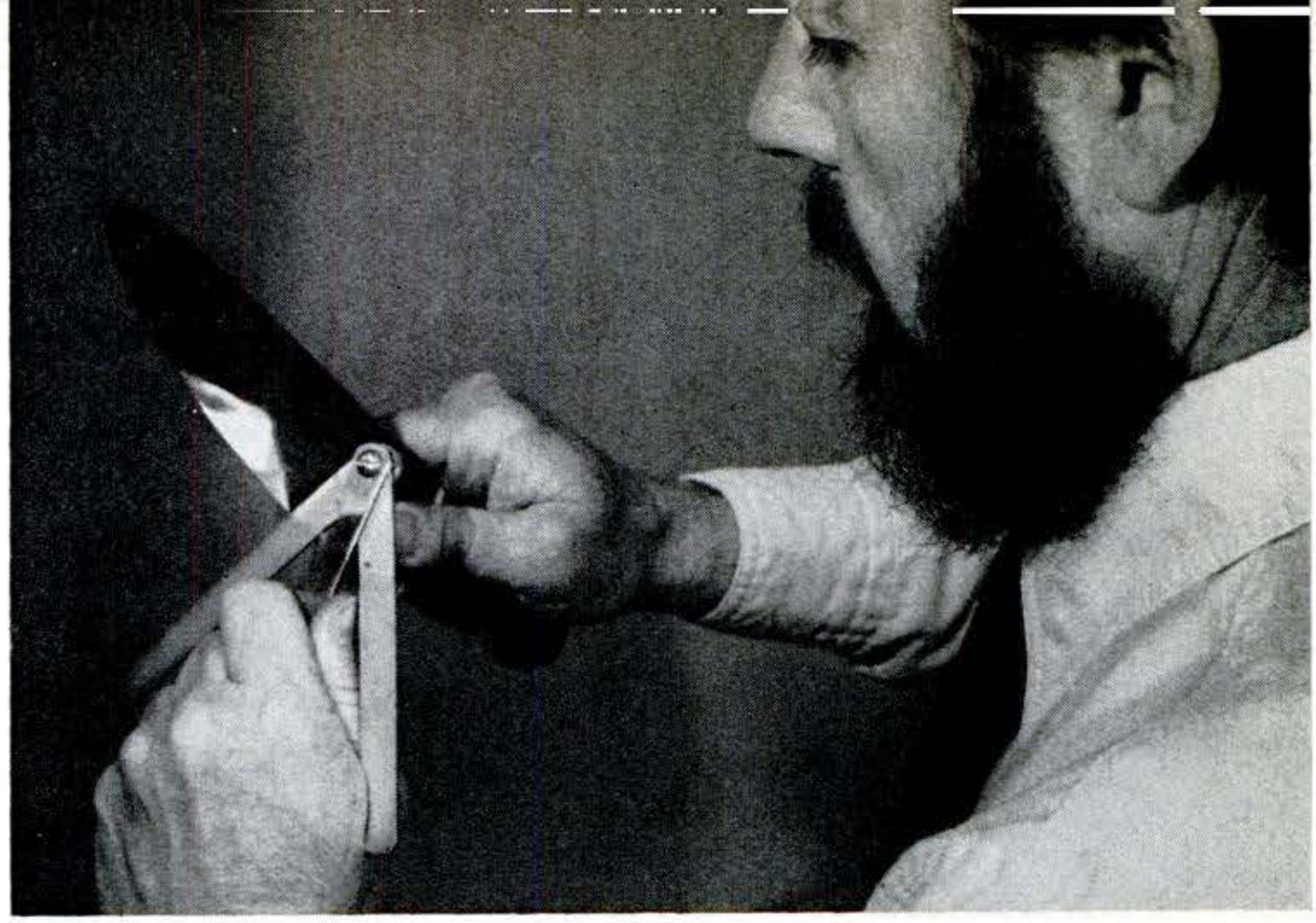
Considering how long people have been using sharpened edges, you'd think we'd know a lot about them. But most people—even professionals in the field—don't. I've seen men who have been sharpening knives for half a century and still have little idea of what they're doing. We've found that the largest meat-packing companies in the world don't know what to tell new employees when it comes to sharpening.

Before I get down to the secrets of sharpening, let me tell you some of the things we've learned that *aren't* true. First, despite what you hear to the contrary, fine manufactured hones are far superior to the natural ones. That's not to say that natural hones are no good; they're just highly overrated.

And second, I'd like to puncture the biggest myth going—and I can hear the howls already. But we've learned the hard way. *You're better off with a dry hone.* I don't care what every sharpening book in the world says. You can save that oil and use it in your crankcase. The basic problem with using oil for sharpening is that as you sharpen, grit from the hone and steel particles from the blade become suspended in the oil and form a slurry. The very fine edge you're putting on the blade actually runs into the particles of hone suspended in the oil. It's as though you were trying to sharpen your blade by running it through a sandpile.



For true sharpness, try the Razor Edge steel. With the wings set to the proper angle and the knife blade parallel to the center support, the blade wipes the steel edge at precisely the right angle.

I've had this point proved to me many times. A few years ago, we were called into Iowa Beef, the world's largest. The meat cutters thought our edges were great, until one day management asked us why we didn't use oil. We explained the situation, but they asked us to try anyway, just to see what would happen. So we used oil.

It wasn't long before the reports started coming back from the lines that the quality of the edges had dropped. So we cleaned all the oil off the hones and the reports suddenly got better.

If your hone is saturated with oil, wash it thoroughly with hot water and soap before using it next time. Keep your fine hones clean by wiping with a rag; vigorously slap coarse hones on your hand, and all the loose particles will fall out.

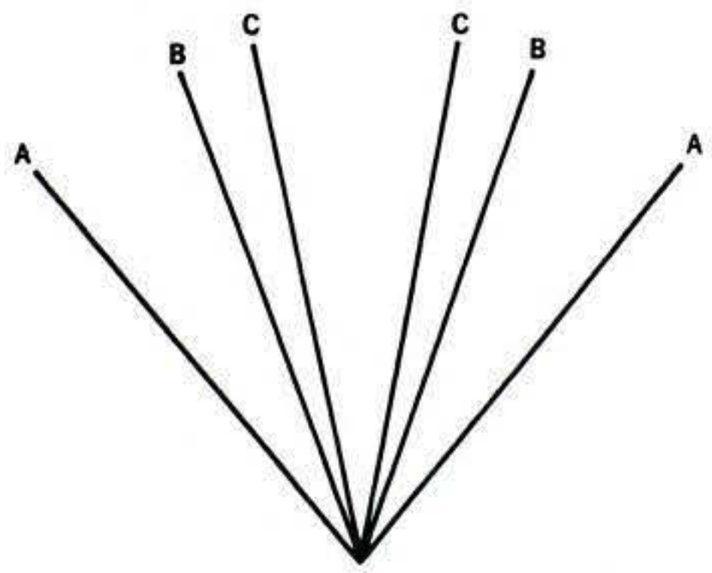
One final tip: All new hones come with a smooth, dull finish on them and will not work properly until you wear through that surface.

As for sharpening itself, it doesn't

Continued

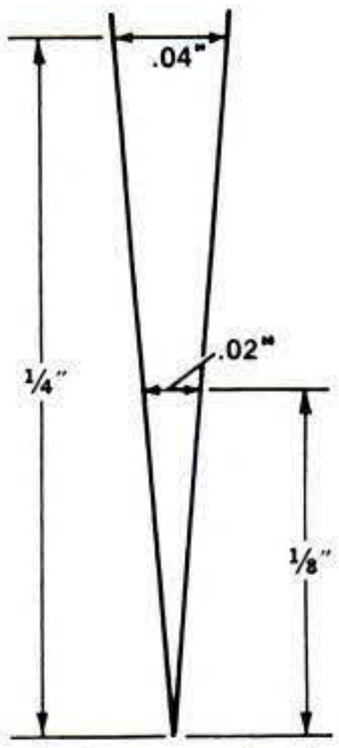
Edge design and sharpening

Edge design starts with a decision on how much taper to build in, and is determined by what you plan to do with the edge. The rule is to taper it back just short of the point at which it will collapse when worked most severely.

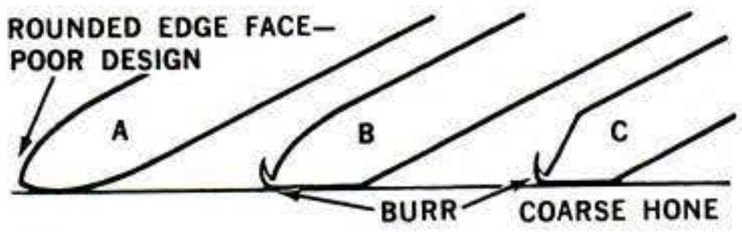


Thus for a chisel, A would be best. For a knife designed to do everything from cutting rope to opening 55-gallon drums, B is a good choice. But for a professional meat cutter and most of your kitchen, hunting, and pocket knives, taper back to C.

For meat cutting, Juranitch hollow-grinds the taper this way: The blade is 0.02 of an inch thick an eighth of an inch behind the cutting edge, and 0.04 of an inch thick one-quarter inch back. The tapering is called "relief," and its importance cannot be overstressed. A blade with good relief will sharpen quickly; one with poor relief, slowly. Only a blade with good relief will take a superior edge.

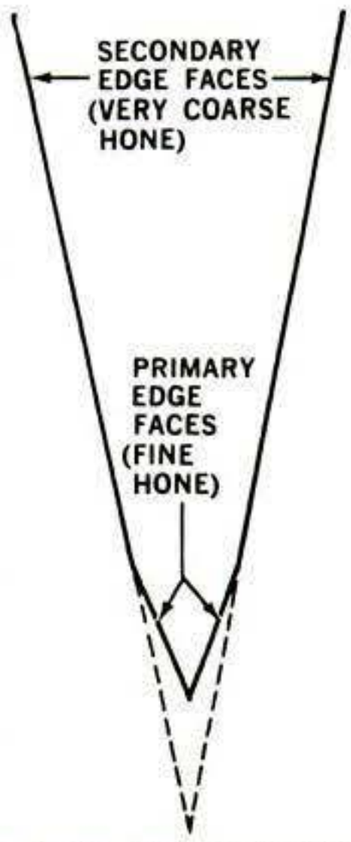


Keep taper angle in mind as you begin sharpening a blade. Chances are, a dull blade looks something like A. Held at



the proper angle during sharpening, it will grind to shape B. When it reaches this point, a small burr will rise as shown. This is critical; it tells you that you have ground enough. You may not be able to see the burr, but you can feel it by running your finger over the edge at a 45-degree angle or by running a fingernail across the edge. Now turn the blade over and grind on the other side, making sure your burr comes up (C).

The most important secret of sharpening: To this point, the blade has been ground to form a *secondary* edge face. But for a really sharp edge, you must form the *primary*-edge faces that come together to form the actual cutting edge. The secondary faces were formed on a coarse hone, since a good bit of metal might have had to be removed. Now, for the primary edge, switch to a fine hone and increase the angle. This is called double edging and is the secret of a really fine edge.



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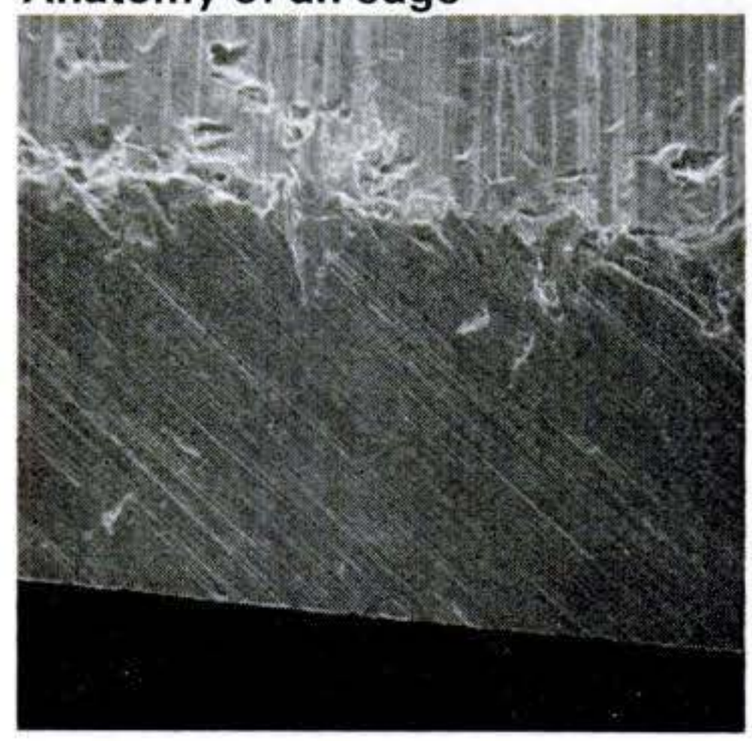
make any difference what kind of blade you have. Sharp is sharp, whether you're cutting whiskers, leather, wood, or meat.

When you begin a sharpening job, remember the two critical steps. First, do a good job of tapering the edge back with the coarse hone. This produces blade relief, and is the most important part of sharpening (the diagrams show why). A blade with good relief will sharpen easily to a high-quality edge. Second, set the primary cutting edges with your fine hone. Don't get too anxious, pay attention to your angles, and you'll always be able to get a knife edge that will shave the hair on your arms without touching your skin. For further info, write Razor Edge Systems, Box 604, Ely, Minn. PS

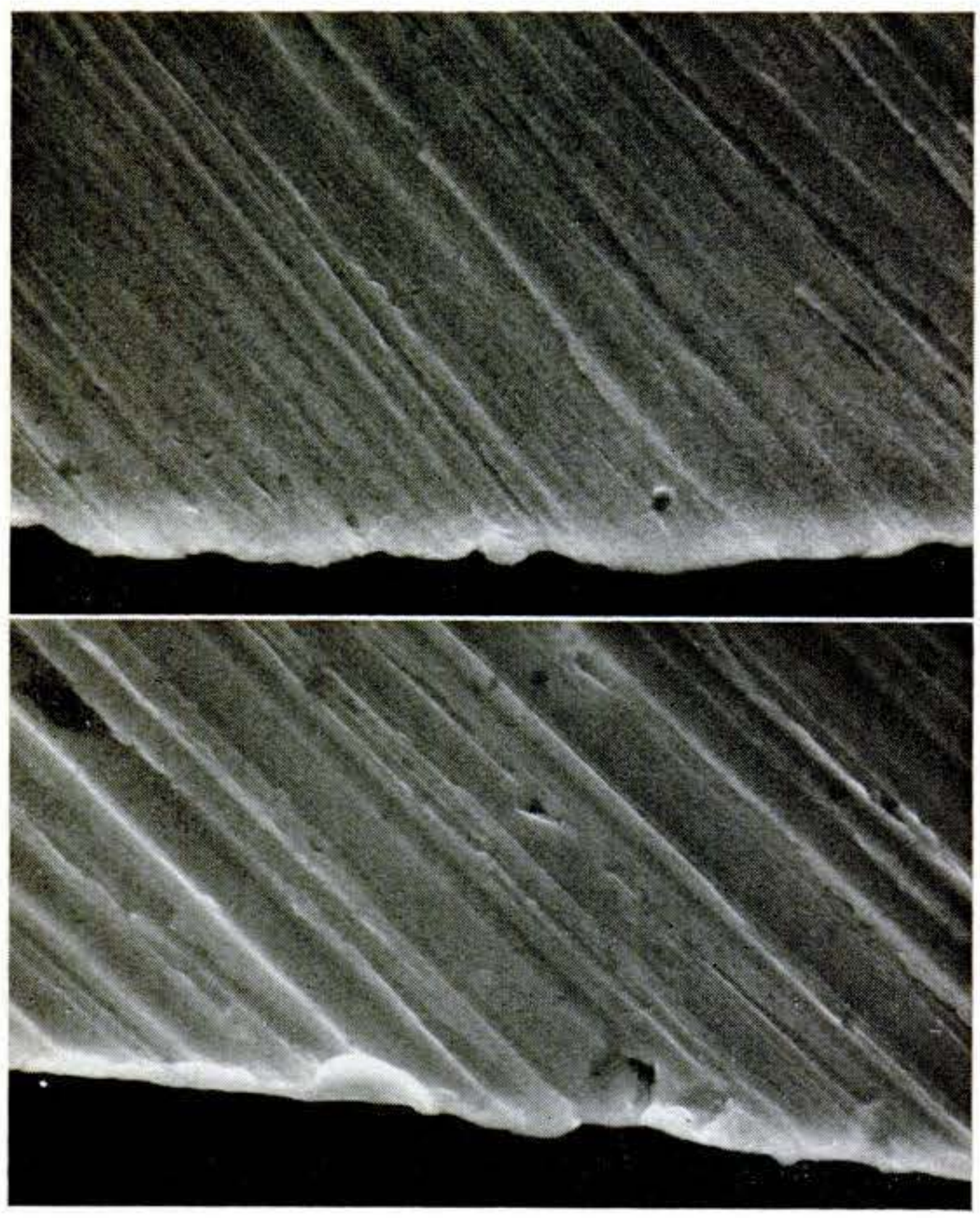
What does an edge really look like?

The editors of *Popular Science* were curious about what an edge looks like under high magnification. So John Juranitch sharpened a number of knives by different processes, then cut almost through the blades on a grinding wheel so that we could snap off one-inch-long sections and have them photographed under a scanning electron microscope. We took them to Structure Probe, Inc., of Metuchen, N.J., where the following pictures were made.—*C. P. Gilmore*

Anatomy of an edge

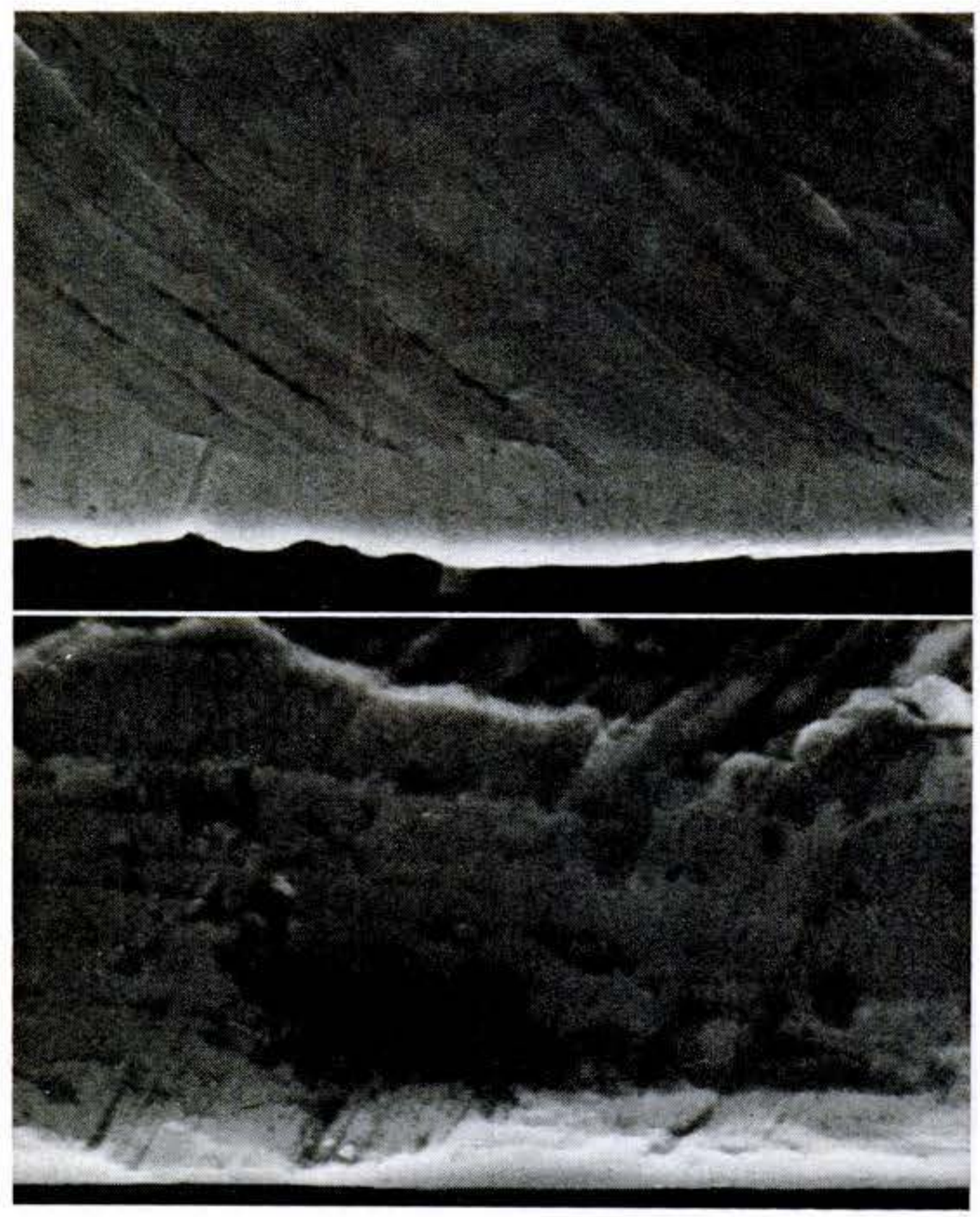


At 100X magnification, the secondary edge shaped with the coarse hone can be seen at top. The smoother surface below is the primary edge.



Oil vs. dry honing

An edge made by a hone has some tooth pattern no matter how sharp. These edges are shown at 3000X magnification. The dry-honed edge (top) is somewhat rough. But the one honed in oil (bottom) has several large chips taken out of it—something like an arrowhead that has been chipped away to produce an edge. Juranitch suspects these chips were caused by particles of grit suspended in oil, claims this edge would not compare with a *really* sharp dry-honed edge.



Try steeling for a really superior edge

The steeled edge has been smoothed out (top) into an even sharper cutting edge, as though someone had wiped the frosting on a cake with the side of a knife. Notice that there are no primary furrows (caused by the hone) left in the steeled area. Bottom photo shows a more heavily steeled edge. The metal has actually flowed back as though it were molten. This is an edge no hone will ever equal. But be careful not to oversteel. In some microphotographs we've taken, you can see a thin hair of metal peeling away from such an oversteeled edge. That ruins the edge and the blade has to be honed again.

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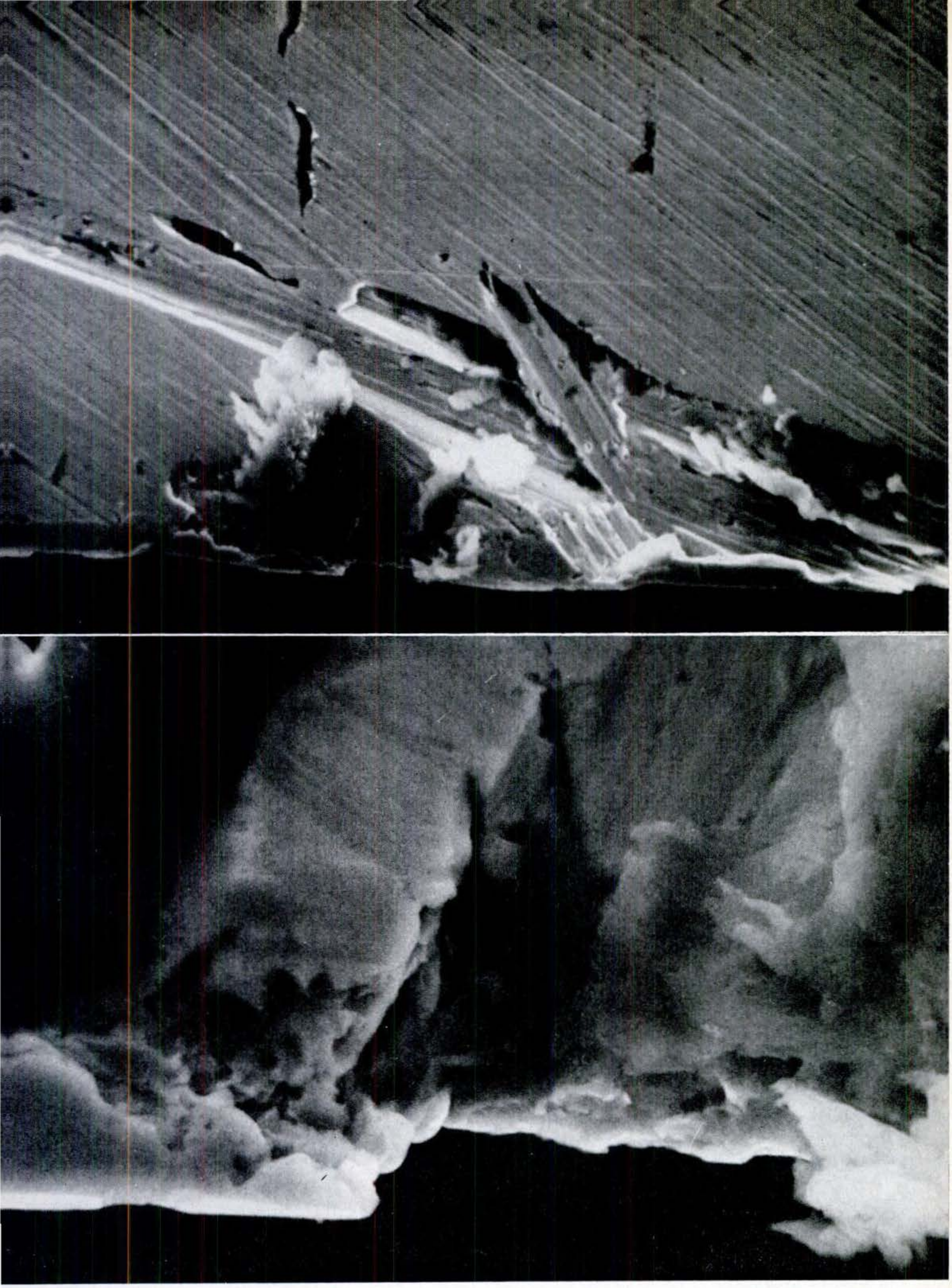

Why edges need resharpening

We took a perfectly sharpened blade and pulled it across the corner of a piece of hard wood a half-dozen times, then photographed it. At 1000X (top), damage is evident. Fragments of what used to be an edge are fractured and lie useless on the side of the blade. (A portion of the undamaged steeled-edge face can be seen to the left.) At 7000X (bottom), it looks as if craters have been gouged out. Yet such damage is fairly easy to hone and steel back to a keen edge.

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How to buy plywood

Always match grade and thickness to the job you want the panel to do

Whether your project for the PS/APA Contest (details below) is a workbench, wine rack, or planter, it'll be easier to build and finish if you select the appropriate type and grade of plywood. In fact, you must do so to qualify. And even if you don't win one of our $1000 prizes, any plywood project will last longer and serve you better if you start with the right panel for the job.

What's the best plywood for your design? First, consider: Will you use the completed project indoors or out? Will both sides of the plywood show? How will you finish?

Next, check our chart (next page) to compare the grades you're most likely to find at your home center or lumber yard. (Several of these may not be stock, but your dealer can order them for you.)

For an outdoor project, choose an exterior type. Finished properly, it'll stand up to wind and weather because it's made with a 100-percent waterproof glueline. Exterior type plywood is also the best choice for interior projects that'll be exposed to moisture or high humidity.

If you're using sanded plywood for an outdoor project where both sides of the plywood sheet will show, choose A-B Exterior. Both sides will be smooth and paintable; or, if you like the natural look, use a water-repellent wood preservative that'll leave the grain visible. When the appearance of one side is less important than the other, use A-C.

The other grades available at most lumber dealers include B-B and B-C Exterior, which are good for such utility uses as a doghouse or storage shed. C-C Plugged is an excellent base for tile and high-performance coatings; if you're building a bathroom vanity top that'll be covered with plastic laminate, C-C Plugged gives a firm base.

If you're planning to paint your project, you'll like MDO—medium-density overlaid plywood. Faced with a smooth resin-treated fiber surface that's heat-fused to the panel veneer, MDO rarely shows any of the checks that can appear on other panels after years of exposure.

For an indoor project where both sides of the plywood panel are important—that wine rack, for example—select A-B Interior. It also makes handsome cabinet doors and furniture. When only one side of the sheet will show (the workbench, say), substitute A-C Exterior or A-D Interior.

Whether you're planning an indoor or outdoor improvement, you'll find a variety of special textures available in the APA grade-trademarked 303 plywood sidings. Originally designed for siding and interior paneling, these patterned sheets can be used just as easily for room dividers and built-ins.

What thickness of plywood should you choose? You'll find that 1/4, 3/8, 1/2, 5/8, and 3/4 inch are the most common, although several grades are also available in thicknesses up to 1 1/4 inch. Some of these thicknesses (and such grades as A-A Exterior or Marine) can be special-ordered through your dealer.

If you're building a stereo or television cabinet, sewing table or desk, select one of the thicker sheets that'll provide a strong, stable surface. For example, 5/8-inch plywood will easily support a television or sewing machine, if properly braced. For that wine rack, try 1/2- or 5/8-inch-thick plywood; for a bench or chair, 3/4 inch is best.

When you use plywood for shelving, the face grain should always run across the supports. If your shelf span is 24 inches or less, you can use 1/2-inch plywood for a bookcase or utility shelving. But if you're storing heavy power tools or building materials, 5/8- or 3/4-inch would be a better choice.

For more information about plywood, send 50¢ to American Plywood Association, 1119 A Street, Tacoma, Wash. 98401. Ask for the 24-page Plywood "How To" Book.

Single-sheet plywood project contest rules

Popular Science, in association with the American Plywood Association, is looking for fresh, clever, well-designed projects that take full advantage of the practicality and economy of structural plywood. Whether you've already built a project that qualifies under the rules below, or wish to design and build one for us now, your ingenuity may be rewarded with a cash prize and publication in a future issue of *Popular Science*.

● **PRIZES:** A $1000 check will be mailed to the First Prize winner in each of two categories (Indoor and Outdoor). Five Honorable Mentions in both of these categories will qualify for a package of how-to books.

● **HOW TO QUALIFY:** Your project must be constructed from a single 4-by-8-ft. sheet of APA-grade-stamped plywood appropriate for the intended use, of proper thickness for structural strength; exterior grade for outdoor projects, interior for indoor (except for wet-area use). Projects must be carefully designed for efficient layout on a single plywood sheet; parts should be scaled, arranged, and nested to minimize waste. Your total expenditure for non-plywood materials should not exceed $75. Any project—functional or decorative—will qualify if it represents an efficient use of a single sheet and can be constructed with home-workshop tools.

● **HOW TO ENTER:** Fill out our entry coupon (or list all information the coupon calls for on a separate sheet of paper—including a rough sketch of the APA grade stamp on the back face of the plywood panel you chose). Mail this with at least one clear photograph and a dimensioned sketch of how the project parts were laid out on a single 4-by-8 sheet of plywood. We also need a list of all materials used: grade and thickness of plywood, plus any lumber, hardware, and finishing materials (paint, stain, plastic laminate). Also jot down for us any special construction tips you'd like to pass along. Unless your entry photo is a color transparency, the negative must be available in case your entry print isn't publishable. If no usable negative exists,

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	Grade designation	Description and most common uses	Typical grade-trademarks	Most common thicknesses (inch) 1/4	5/16	3/8	1/2	5/8	3/4
Interior type	A-B INT-APA	Use where appearance of one side is less important but both faces must be smooth and sound.	AB G4 INT APA PS 1-74	✓		✓	✓	✓	✓
	A-D INT-APA	Use where appearance of only one side is important: paneling, built-ins, shelving, partitions.	A-D GROUP 1 INTERIOR PS 1-74 000 APA	✓		✓	✓	✓	✓
	B-B INT-APA	Utility panel with two smooth sides. Circular plugs allowed.	BB G3 INT APA PS 1-74	✓		✓	✓	✓	✓
	B-D INT-APA	Utility panel with one smooth side. Good for backing, sides of built-ins.	B-D GROUP 3 INTERIOR PS 1-74 000 APA	✓		✓	✓	✓	✓
	DECORATIVE PANELS—APA	Rough-sawn, brushed, grooved, or striated faces. For paneling, interior accent walls, built-ins, counter facing.	DECORATIVE BD G1 INT APA PS 1-74		✓	✓	✓	✓	
Exterior type	A-B EXT-APA	Use where the appearance of one side is less important.	AB G1 EXT APA PS 1-74	✓		✓	✓	✓	✓
	A-C EXT-APA	Use where the appearance of only one side is important (soffits, fences, structural uses).	A-C GROUP 1 EXTERIOR PS 1-74 000 APA	✓		✓	✓	✓	✓
	B-B EXT-APA	Utility panel with solid faces.	BB G1 EXT APA PS 1-74	✓		✓	✓	✓	✓
	B-C EXT-APA	Utility panel for work buildings. Also as base for exterior coatings for walls, roofs.	B-C GROUP 2 EXTERIOR PS 1-74 000 APA	✓		✓	✓	✓	✓
	MDO EXT-APA	Medium Density Overlay with smooth, opaque, resin-fiber overlay (one or both panel faces). Highly recommended for siding and other outdoor applications, built-ins. Ideal base for paint.	MDO BB G4 EXT APA PS 1-74		✓	✓	✓	✓	✓
	303 SIDING EXT-APA	Proprietary plywood products for exterior siding, fencing, etc. Special surface treatment such as V-groove, channel groove, striated, brushed, rough-sawn.	303 SIDING 16 oc GROUP 1 EXTERIOR PS 1-74 000 APA			✓	✓	✓	
	T 1-11 EXT-APA	Special 303 panel having grooves 1/4" deep, 3/8" wide, spaced 4" or 8" o.c. (other spacing on special order). Edges (but not ends) shiplapped. Available unsanded, textured, and MDO.	303 SIDING 16 oc T1-11 GROUP 1 EXTERIOR PS 1-74 000 APA					✓	

Exterior: Made with quality veneers (A, B, or C grade) bonded with waterproof glue that's so durable that boiling water won't harm it.

Interior: Made with either moisture-resistant or waterproof glue (depending on manufacturer). Though it can be exposed to weather during construction, interior type shouldn't be permanently exposed to moisture. Most interior-type plywood is now made with exterior glue. Such plywood differs from exterior type only in the quality of the inner plies and the back face. However, this isn't a substitute for exterior type. Interior-type plywood may also be bonded with interior glue—a moisture-resistant (not moisture-proof) adhesive. (Less common are types bonded with "intermediate" glue.

Popular Science and APA reserve the right to arrange photography. Entries must be delivered to the Tacoma Post Office Box by April 1, 1977, and become the property of APA and/or *Popular Science*. Print OUTDOOR or INDOOR in the lower-left corner of your envelope (only one entry per envelope, please). No entries can be acknowledged, and none will be returned unless accompanied by a written request and a self-addressed envelope with sufficient postage.

● **JUDGING** (by PS Reader Activities Editor Al Lees and representatives of APA) will be for the most efficient and appropriate use of a single sheet of plywood for either an *indoor* project for the home or an *outdoor* project for the patio or yard (or for a recreational activity). PS will publish dimensioned plans of those prize-winning projects we feel our readers might want to duplicate. Plans for all 12 prize-winning projects will be available from APA after Sept. 1, 1977.

All 12 winners will be notified by May 1, and will receive their prizes by August 1. The winning entries will be announced in the August 1977 issue of *Popular Science*.

ENTRY COUPON (Clip and attach to your plans sketch)

Mail entry to:
POPULAR SCIENCE CONTEST
Box 2277, Tacoma, Wash. 98401

To qualify, entry must reach Tacoma address by April 1, 1977

YOUR NAME (print or type) _____

STREET ADDRESS _____

CITY _____ STATE _____ ZIP _____

Copy the plywood-grade stamp here

Description of project _____

Check one: ☐ INDOOR ☐ OUTDOOR

What thickness plywood? ☐ 3/8" ☐ 1/2" ☐ 5/8" ☐ 3/4"
If other, check here ☐ and specify _____

My signature certifies that this project is of my own design.

Sign here _____

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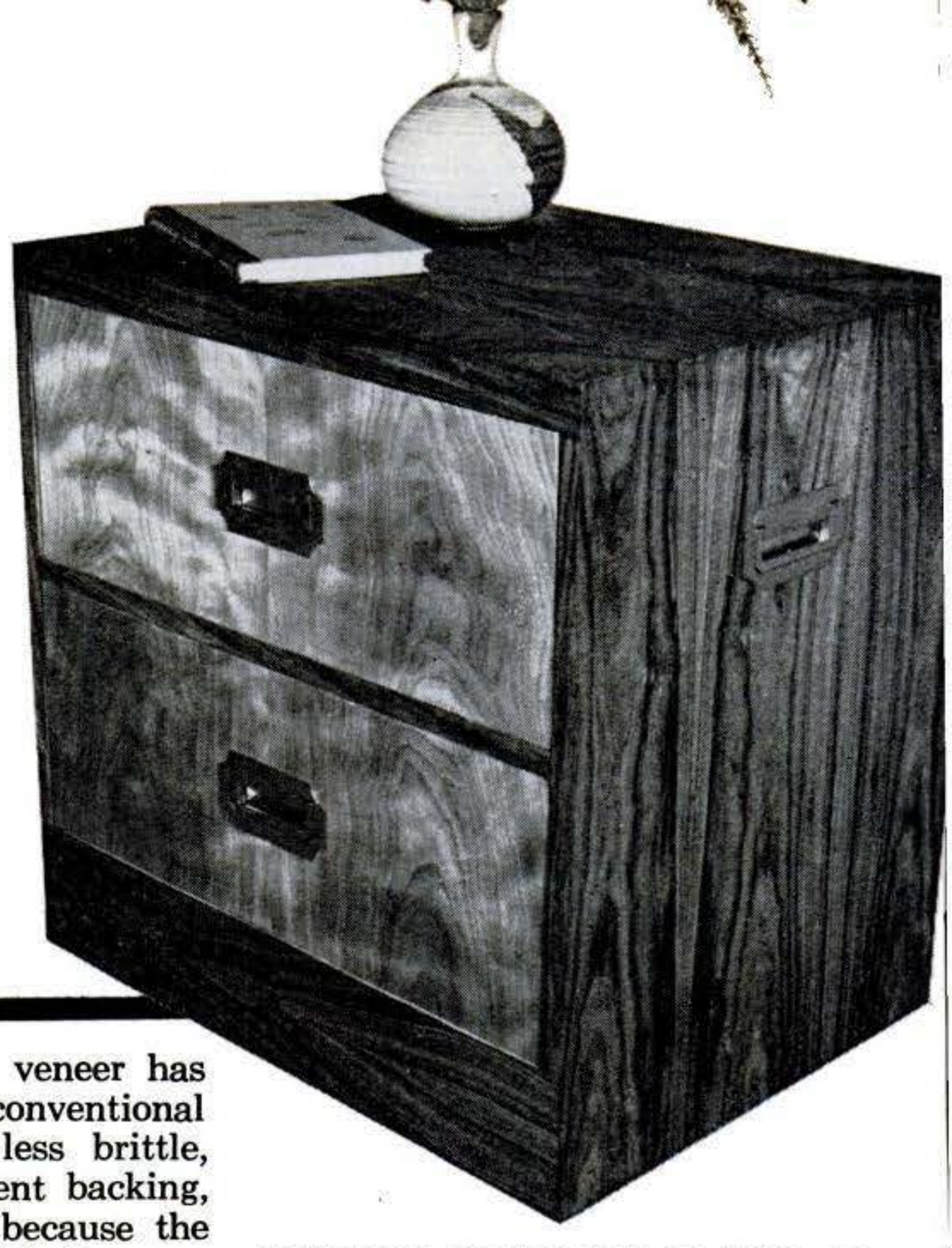
Flexible veneer

–easy, inexpensive route to elegant furniture



Hardwood chest began as plain, unpainted furniture. Easy-to-handle flexible veneer made transformation possible. Chest finish is Brazilian rosewood; contrasting drawers are birch. The 1/64"-thick veneer comes in 10 other woods.

Real-wood veneers tough to work with? No more. They're almost as easy to apply to unfinished furniture as paint

By HARRY JASON HOBBS

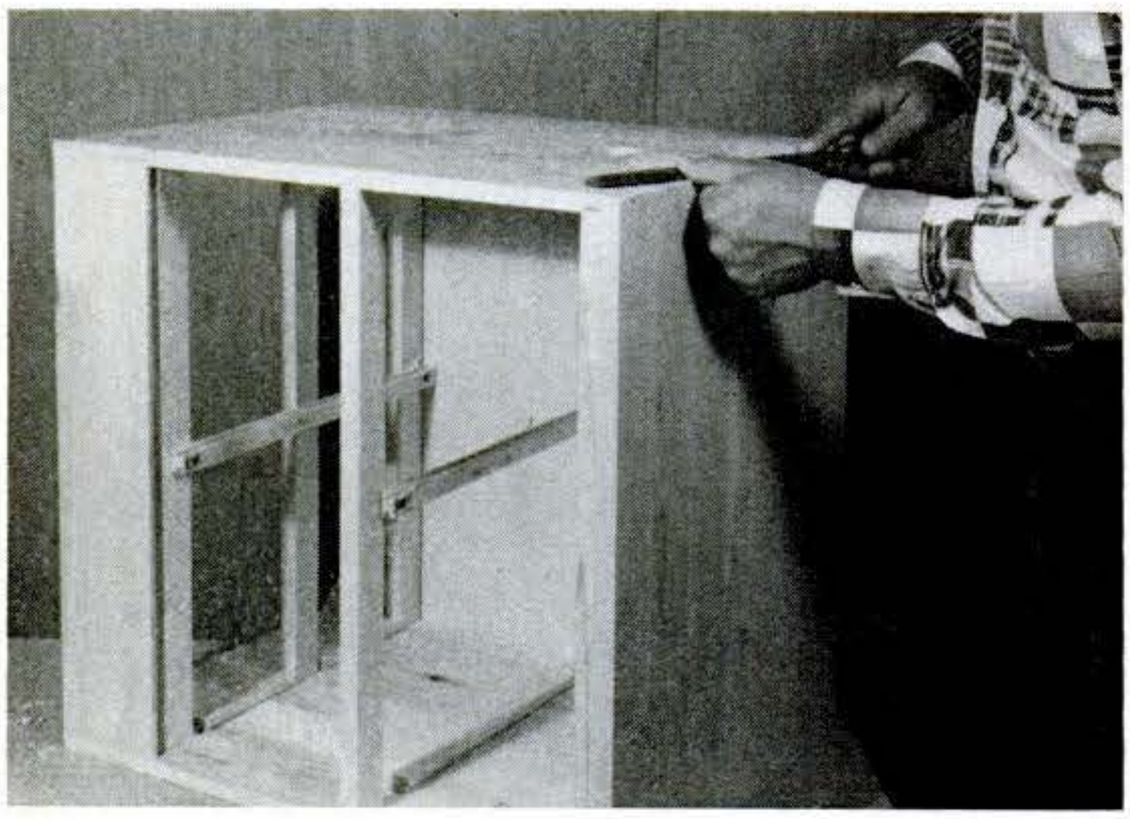
The Egyptians started it all. To get the most from rare hardwood logs, they sliced them with crude saws, then glued the slices to furniture made of less precious wood. Since then, finely crafted veneer finishes have been the hallmark of the skilled artisan because the rippled, brittle veneer sheets are often too difficult for amateurs to fuss with.

A new flexible veneer has changed all this. Available in 12 fine woods, including teak, rift oak, bird's-eye maple, and East Indian rosewood, the new veneer is remarkably easy to handle. The thin (1/64" grade) flexible veneer has two advantages over conventional veneers: It is much less brittle, because of its permanent backing, and it is much wider because the usual narrow leaves of sliced veneer have been edge-joined into wide sheets. Even woodworkers with little experience can apply this veneer, using contact glue, a few simple tools, and no clamps at all.

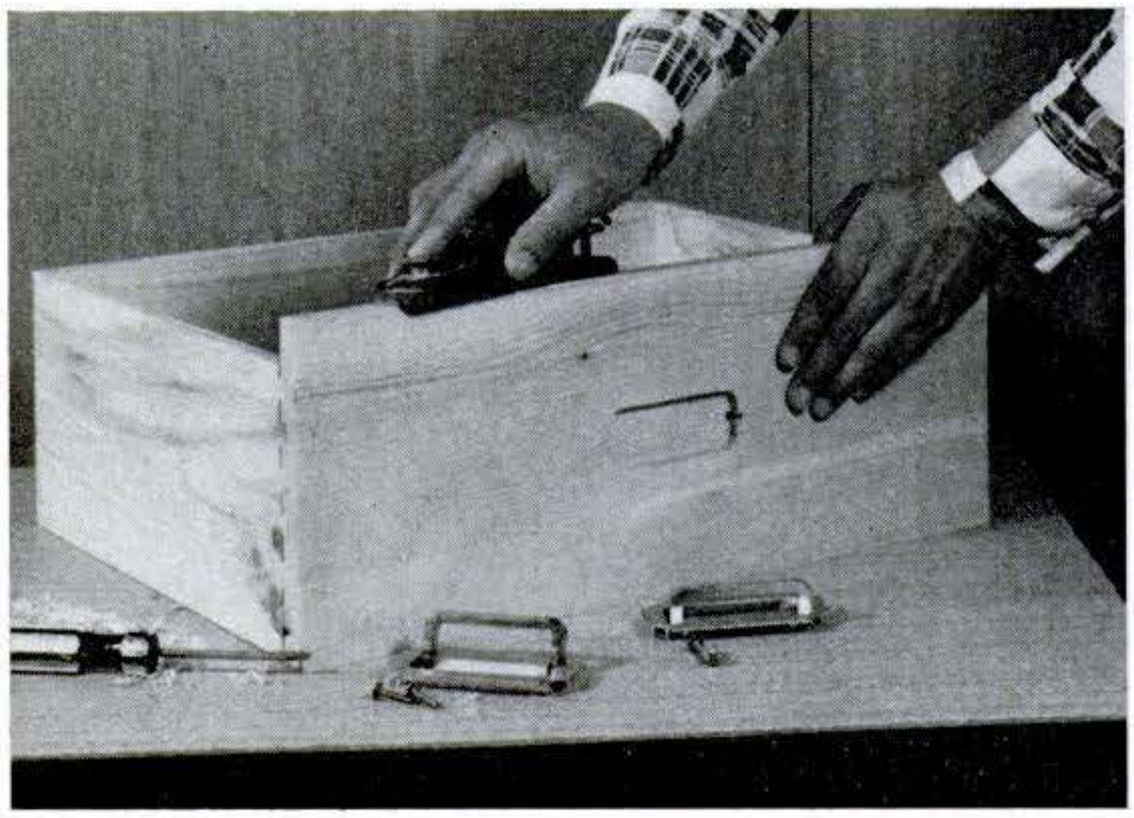
Eight-foot-long rolls of flexible veneer come in three widths—18, 24, and 36 inches. The veneer is being offered for the first time in a mail-order catalog (50c) from Albert Constantine and Son, 2050 Eastchester Rd., Bronx, N.Y. 10461. Prices range from $1.25 per square foot for cherry veneer to $2.95 per square foot for Brazilian rosewood. Minimum order is one eight-foot roll.

You can use flexible veneer to finish unpainted furniture or to refurbish scruffy but sound old furniture. The furniture should have flat surfaces and square edges; rounded corners and molded edges can't be veneered. If your old furniture has rounded edges you can strip the old finish and refinish with stain that matches the veneer used on the rest of the piece. In fact, furniture with varnish, lacquer, or wax finishes should be stripped to provide a good bonding surface for the glue. Pitted surfaces and places where old veneer

Continued



Before applying veneer to unpainted chest, check for square edges. True with cabinet rasp and sandpaper.



2 Use block plane to trim top and side edges of drawer for loose fit. Forcing drawers could chip veneer edges.

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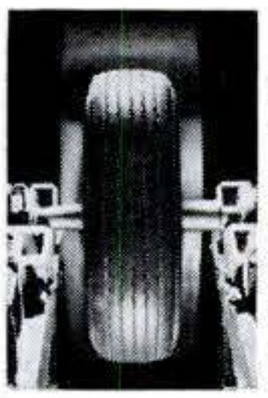
Sears RoadHandler. Better after 40,000 miles than Federal standards say a new tire has to be.

Sears believes in giving you the facts about its tires. Here are the "Proof of Performance" facts about Sears best Steel-Belted Radial.
With 40,000 miles of relentless day and night driving already behind them, four Sears RoadHandlers set out to tame the rugged 2,000 mile route of the old Pony Express.

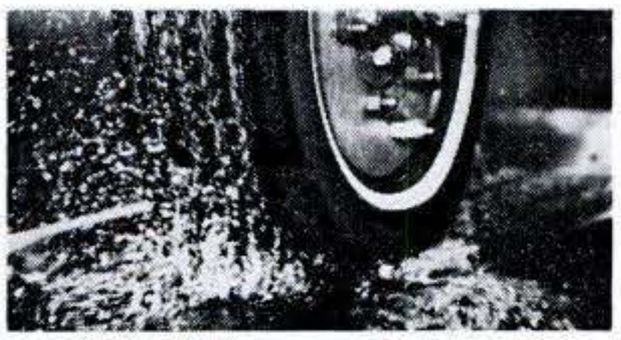


The warm-up over, we put them to the real test: Department of Transportation Federal Motor Vehicle Safety Standard 109 for *new* tires.

Results? Sears RoadHandlers exceeded every government requirement, *e.g.* for strength, heat resistance and bead unseating (keeping the tire on the rim in hard turns).

Even when subjected to X-ray examination of the complete tire, these RoadHandlers showed no failure of any kind anywhere.

No wonder they're Sears best Steel-Belted Radial.



15% better wet cornering than Sears original Steel-Belted Radial.
A new wet cornering traction record for Sears tires! Under carefully controlled laboratory conditions at Calspan Tire Research Facility, Sears RoadHandler beat (by an impressive 15%) the original Sears Steel-Belted Radial that beat the Baja.

Two reasons why: 12.5% more rubber meets the road for quicker, surer stops. And more water is channeled along 5 tread grooves instead of 4 to help prevent *hydroplaning* (skidding on the thin film of water between a rainy road and the tire's surface).

Sears
Tire and Auto Centers and Catalog.

"Straight talk, good values and satisfaction."

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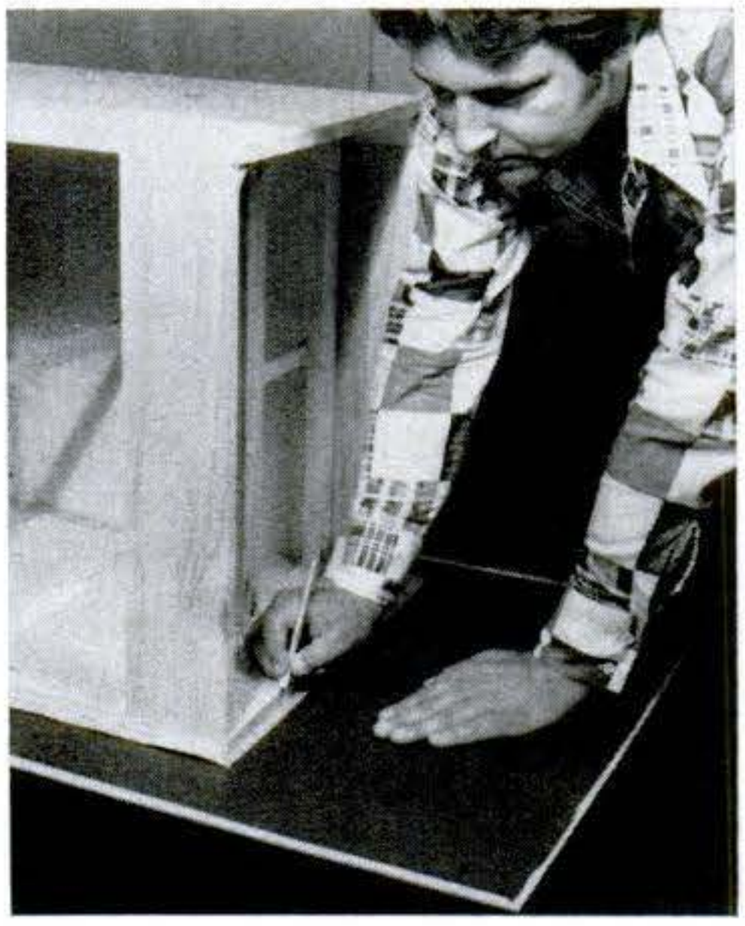
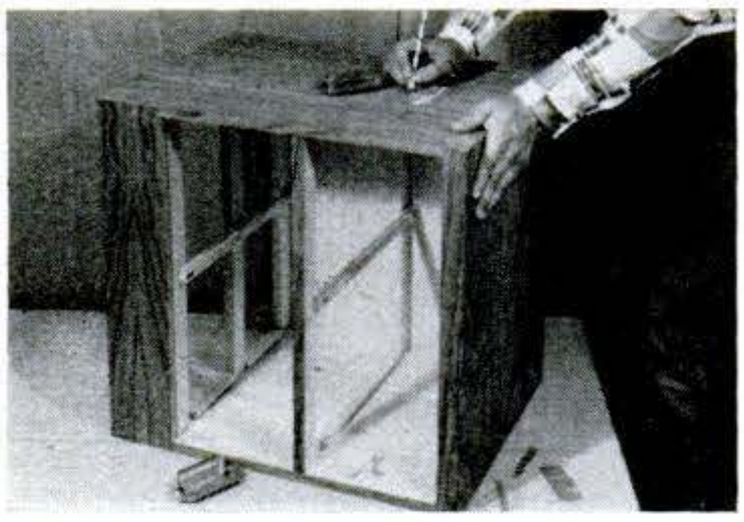
3 **Weight veneer** with bricks (in plastic bags to prevent scratches) as you cut sheets you need from roll.

4 **Brush heavy coat** of contact glue on underside of veneer and on chest surface. Give second coat an hour later.

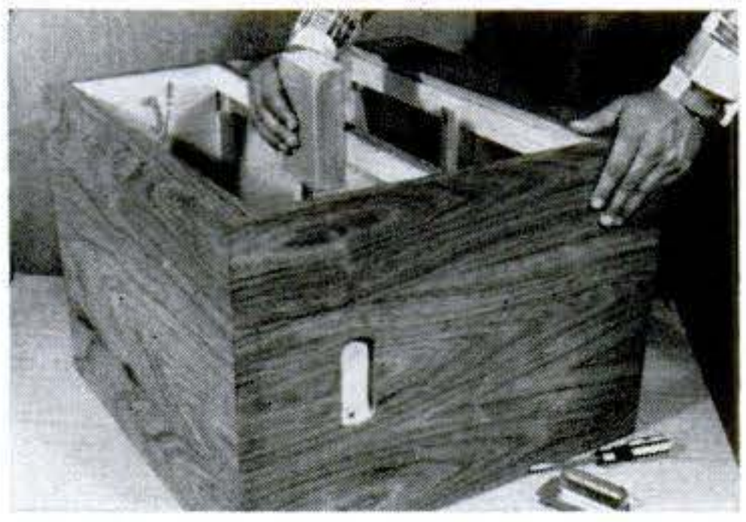
5 **Wax paper** separates glue surfaces. Pull paper back a bit at a time; finger-press veneer down, then roller it.



6 **Trim overhang** from edges with fresh knife blade. Use chest edge as cutting guide; avoid nicking edges.



7 **Lay veneer** right over handle holes. To open, cut around edge and remove veneer. Trim, then attach handle.



8 **Use very fine sandpaper** and gentle, lengthwise strokes to smooth cut edges. Never stroke *across* veneer edge.

has chipped off can be filled with nonshrinking powder wood compound mixed with water and sanded smooth when hard. Once old furniture is stripped down, apply veneer, using the techniques shown (see photos) for veneering the unpainted chest.

To demonstrate the variety of design possible, we covered the chest's drawers in a contrasting wood. But one eight-foot-long, 24-inch-wide roll of veneer is enough to cover the two-drawer chest (21½″ high, 21½″ wide, 16½″ deep, from J. C. Penney, No. R804-2327A).

Prepare for veneering by removing all hardware, squaring up edges, and trimming drawer fronts. Prefinish other drawer surfaces (we used clear lacquer).

Don't sand surfaces as much as you would before applying a fine finish; glue bonding is better on a surface that isn't mirror-smooth. Plan to veneer one surface at a time: The best method is to veneer last the surface that shows the most. To veneer the top of a coffee table, for example, you'd do the edges first and the top last. For the chest, you'll do the sides first and the drawer fronts last.

Before cutting any piece from the roll, make a small-scale layout of all needed pieces, adding in the overhang allowance (about ¾″ on larger pieces, less on smaller). Plan your cuts so that the grain will run in the right direction: vertically on the sides; horizontally on top and on front rails, front edges, and drawer fronts. For the 21½″-by-21½″ side, for example, you cut a piece 23″ square; the extra 1½″ gives you ¾″ overhang all around.

To cut, lay the veneer, grain side up, on a clean, smooth cutting surface such as a panel of particle board or hardboard. Don't use plywood; it's too uneven for knife cutting. Use a 24″ steel straightedge as a cutting guide and a craft knife with an X-acto No. 11 blade for the cleanest cut. Use only a fresh blade and replace it often.

After cutting, spread a fairly heavy coat of nonflammable contact glue on both the veneer and the chest side. Be sure to keep glue surfaces far apart; if they touch, they'll weld. Allow 60 minutes for the glue to dry (cut the next piece while you're waiting), then apply a second coat of glue to both surfaces, making sure to cover any thin areas.

Applying the veneer

Let dry another hour, then lay a slipsheet of wax paper or heavy brown paper on the chest about ¼″ back from the edge. Place the veneer on top of the slipsheet, and align it with the chest side, letting about ¾″ extend over the edge. When perfectly aligned, rub veneer down against the exposed ¼″ strip of chest. (Don't press heavily over the slipsheet because the veneer will adhere somewhat to the paper.) Pull the slipsheet back to expose another inch or so of veneer, press, then apply fairly heavy pressure with a roller, always moving in the grain direction (crosswise rollering could split the veneer). Continue the same process to the end of the panel; be careful with the roller at all overhanging edges. Roll the whole surface once more to assure perfect contact.

Let the glue harden for an hour, then trim overhanging edges. Make several passes with the knife instead of trying to cut through in one pass. Finish with light strokes of a sandpaper block to remove any unevenness from the knife cut.

Continue to lay one piece at a time, in the following order: second side, top horizontal rail, top, bottom and center rail, vertical edges, then drawer fronts.

Deft spray lacquer was the only protective finish we applied; it shows off the natural beauty of the wood grain. For a glossy finish, coat it with paste wax. PS

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by Ted Nicholas

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Find out why lawyers charge huge fees for incorporating services even when often times they prefer not to. There is a fallacy in that most people feel it is necessary to have a lawyer to incorporate.

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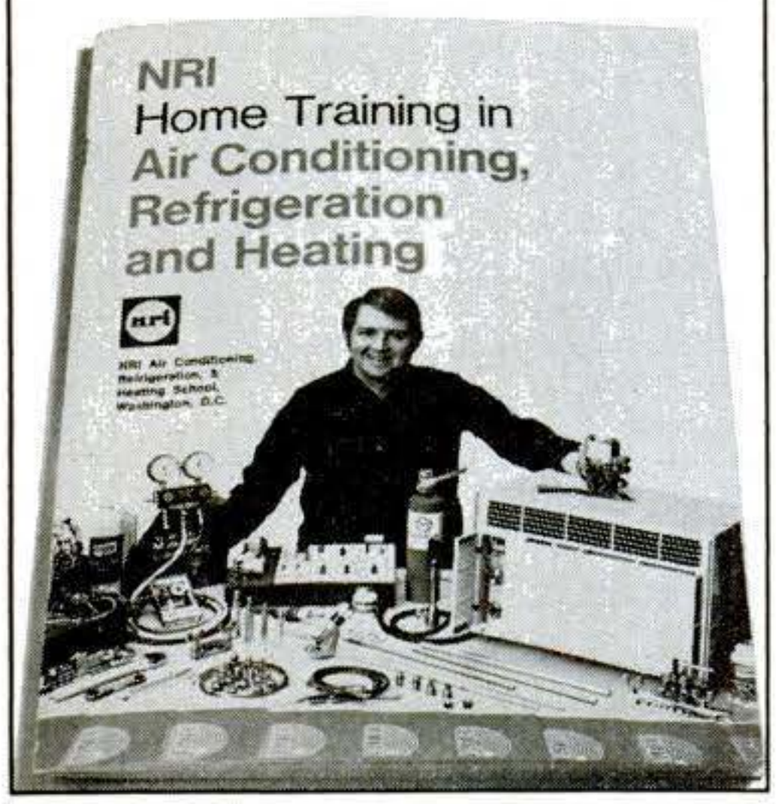


Air shocks for motorcycles

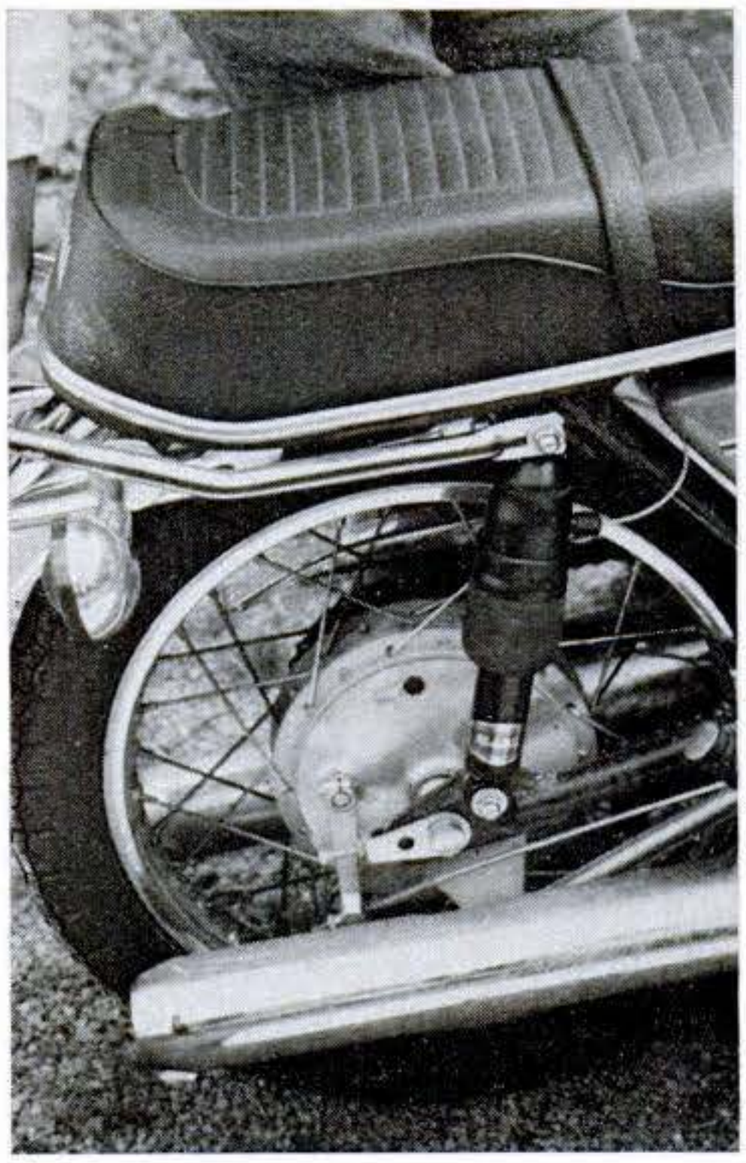
Are you a motorcyclist who's tired of poor response from stock shocks and springs on all but the smoothest roads? You'll be delighted with S&W's new air shocks—first ever for bikes. They do away with rear springs and are almost infinitely adjustable (just add or release air).

Installation is fairly simple, taking only 1½ hours, but is not just a shock-for-shock swap. First, old shocks and springs must be removed. Then the new units are installed. After that comes the hardest part. A location must be found for the fill valve and equalizer. S&W recommends the tool tray under the seat. On the Yamaha RD 350 we used, there is no room under the seat, so we used the top mounting bar for the taillight.

After installation, you'll need a high-pressure air gauge to test for leaks. For testing, the system is filled to its maximum of 90 psi. No leaks? Then the pressure is dropped for riding. S&W recommends 30-40 pounds as a start. We used 35 pounds for a 145-pound rider.

What kind of ride do they give? Over short, choppy, stutter bumps, the original shocks caused a lot of rear-end hop. With the air shocks, the hop disappeared. Over larger bumps, the stock suspension would toss the rider well out of the saddle. With the air shocks, much more speed was needed to produce the same result. Rear-end harshness was gone, and a softer ride resulted. But the wobble and float usually associated with soft rear suspensions was absent.

One problem did crop up: With a lightweight rider, the front forks seemed very harsh once the rear end was calmed down. Overstiff springing seemed to be the cause. Bottoming occurred only once, at 70 mph, on a concrete road. Five to 10cc of oil added might prevent this and improve overall handling a bit. S&W feels the need for adding oil—which cuts down air volume—will be rare, and cautions that too much oil will cause a fall-off in overall performance. I liked the air shocks, and I think you will, too.—*Charles Self*



Air shock shown beneath a standard shock in top photo has noticeable differences. Above, air shocks are shown on a Yamaha RD 350. A pair of them costs $48 (chromed set is $58). They're sold by Webco Inc., Box 429, Venice, Calif.

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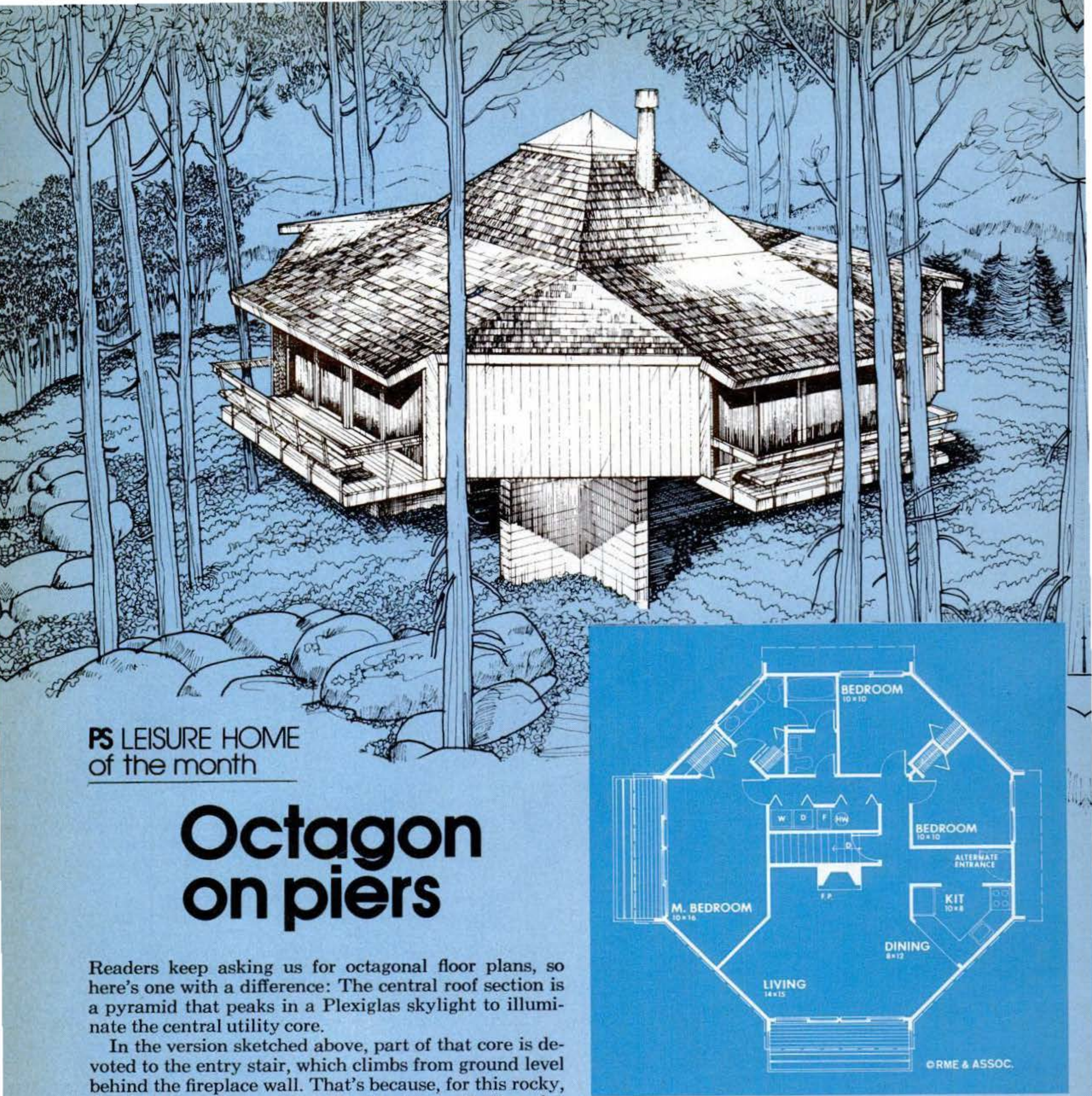


PS LEISURE HOME of the month

Octagon on piers

Readers keep asking us for octagonal floor plans, so here's one with a difference: The central roof section is a pyramid that peaks in a Plexiglas skylight to illuminate the central utility core.

In the version sketched above, part of that core is devoted to the entry stair, which climbs from ground level behind the fireplace wall. That's because, for this rocky, sloping site where excavation is impractical, we've perched our octagon on four right-angled masonry piers. The structure cantilevers beyond these piers on all sides, with an increased thrust for the two deck areas shown. (The dotted perimeter on the floor plan indicates the roof line.) The sheltered area beneath is ideal for storage. At some sites, it could even serve as a carport. If you wished an additional entry, a catwalk could be thrown from the uphill bank to one of the decks, or to the alternate entrance shown on the plan.

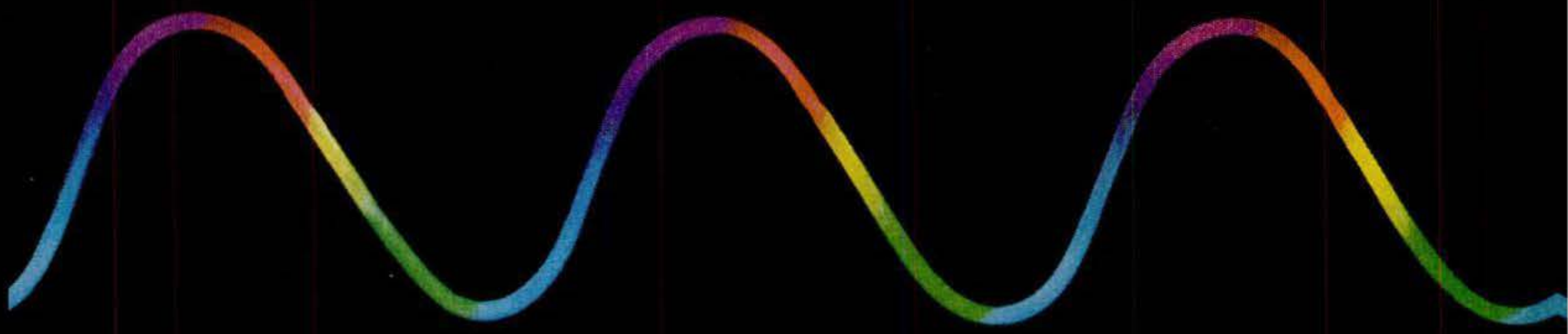
The versatile floor plan could also be adapted to a flat site, erecting the walls from a slab-on-grade. In such a case, there could be direct access to all living areas, and the entry stair would be omitted.

A cleverly compartmented multi-use bathroom complex serves all three bedrooms. Where the site permits, each bedroom could have a private deck like the one indicated here for the master bedroom. Square footage for the house as shown totals 952.

The poly-shaped roof soars toward the skylight beyond the center partitions that define all rooms except the living/dining area; beneath this central section, the partitions are only eight feet high, with the ceiling floating above. Here's the first design in our four-year-old leisure-home series that offers pyramid power! It was created for us by Robert Martin Engelbrecht, under the sponsorship of the V-PAC Council, a building-materials group promoting quality leisure-home design. —*Al Lees*

Several ways to order V-PAC plans

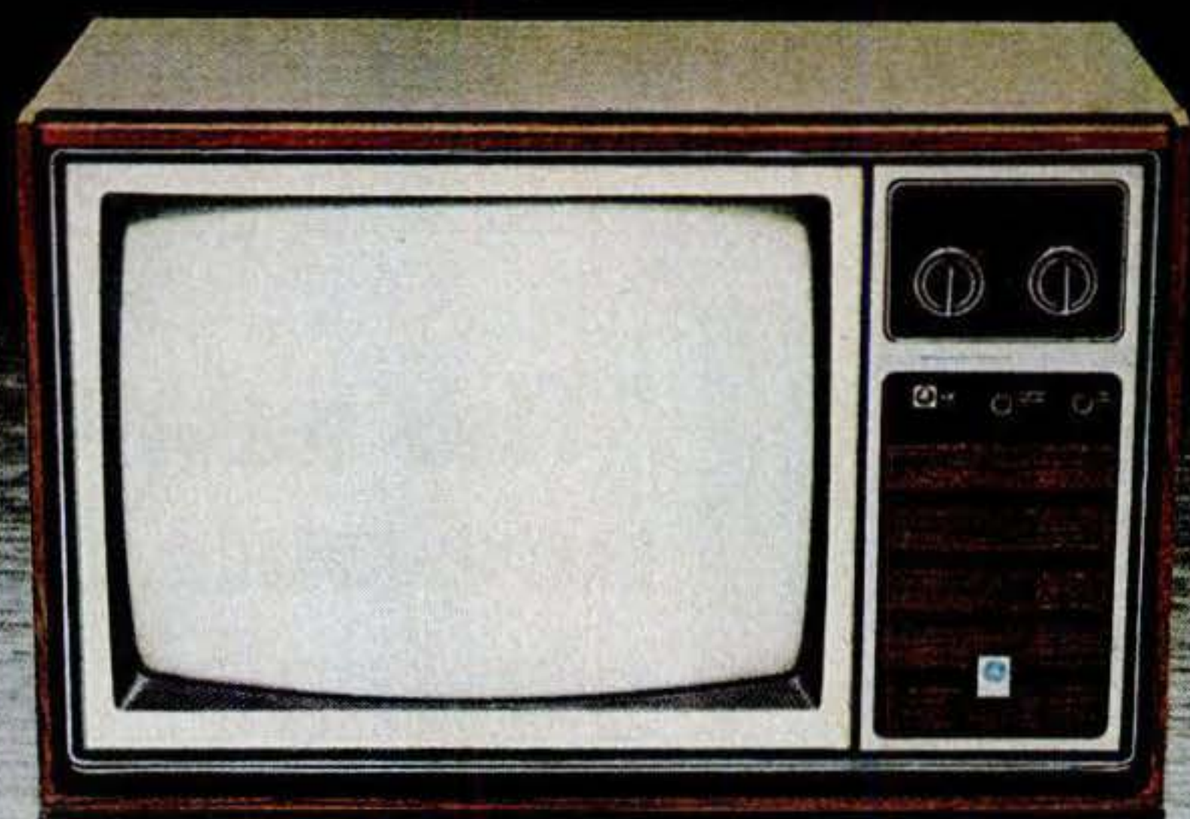
Octagon-on-piers study plan ($1) is floor plan with added data. Plans from earlier series—plus others not published in PS—are cataloged in a pair of V-PAC Guides ($4). Octagon blueprints (VPS #38) are $40; three sets, $55; five sets, $65. Postage and handling, $2. Send orders to Vacation Plans Service, Box 622, Princeton, N.J. 08540 (U.S. funds only).



There's a signal in the air that lets the broadcaster control the color.

There's a set that can use it now.

Ours.



Simulated wood cabinet.
V.I.R. is available on model shown and several console models.

Our set is General Electric. The signal is called V.I.R. And both are remarkable. Many TV programs are now transmitted with this special V.I.R. signal. Advanced computer-like circuitry, in selected GE color models, uses this V.I.R. signal to give you color and tint adjusted by the broadcasters themselves. 60 times every second. Continuously. Automatically. This means you won't have to fiddle with color control settings, because General Electric's V.I.R. system makes these adjustments for you. All you have to do is sit back and enjoy broadcast controlled color.

We invite you to see a demonstration at your GE dealer. Look for the V.I.R. light on a General Electric set. It tells you the V.I.R. signal is being sent and being received by the GE set. Then watch the GE set automatically adjust the color in the picture. You've got to see it to believe it.

V.I.R. Broadcast Controlled Color. GE has it. Now.

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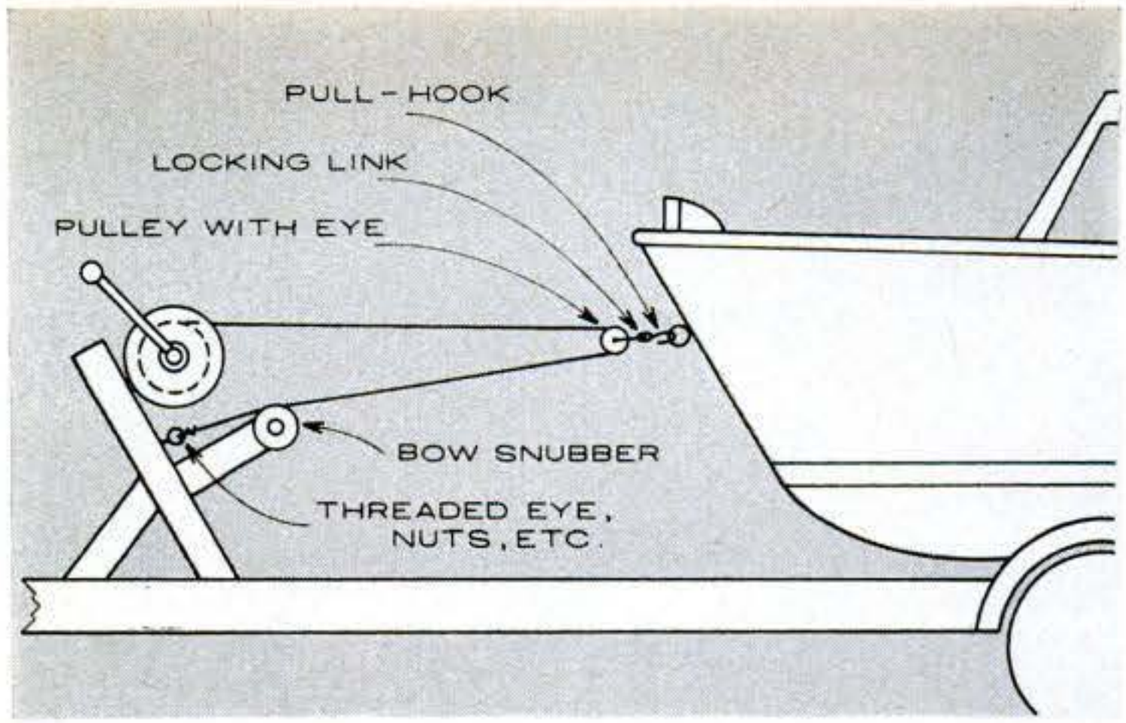


By adding a pulley, you can cut in half the force needed to winch a 16-foot fully-loaded runabout onto a trailer.

Boat-winch conversion
for easier loading

After a full day of boating, any tired "trailer-sailor" will appreciate this helpful method of loading his rig onto the trailer.

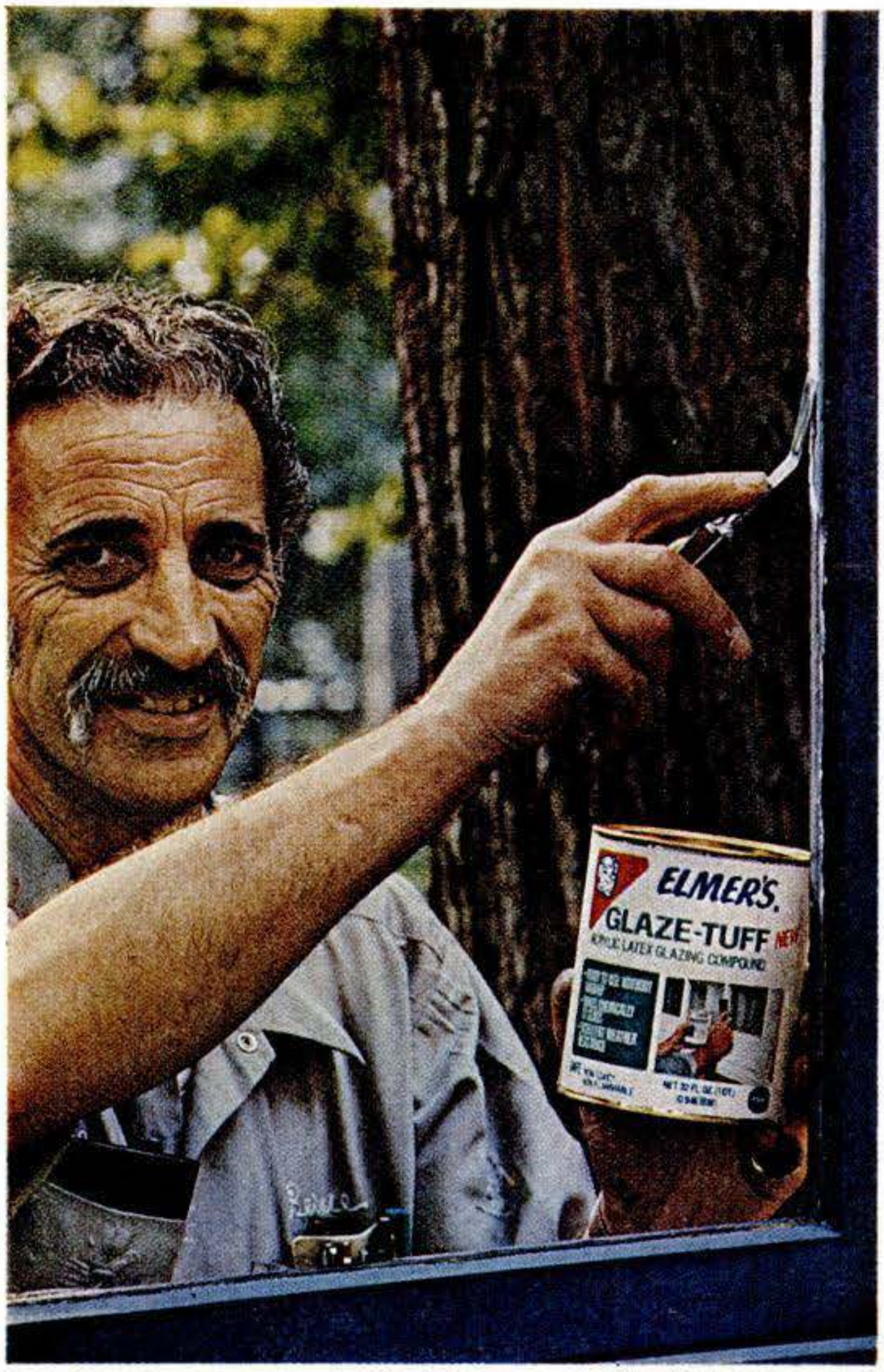
In a conventional crank-winch system, the cable passes directly between the boat and winch. The total force required is the sum weight of the boat, motor, and equipment.

This system adds a pulley so that twin cables share the work; the winch—and you—need haul in only half the total weight.

To convert your trailer, you'll need a single-wheel pulley with eye, a locking link, a threaded eye, and twice your present length of cable. Your trailer winch may already have excess line, but if it's old, this might be the time to replace it.

The changeover should take less than 20 minutes and cost under $2. Disconnect the present pull-hook from its winch cable, then use the locking link to connect the pull-hook to the pulley. Pass the cable through the pulley as shown. Install a threaded eye through the trailer post with double nuts and lockwashers and finally, secure the cable to the eye.

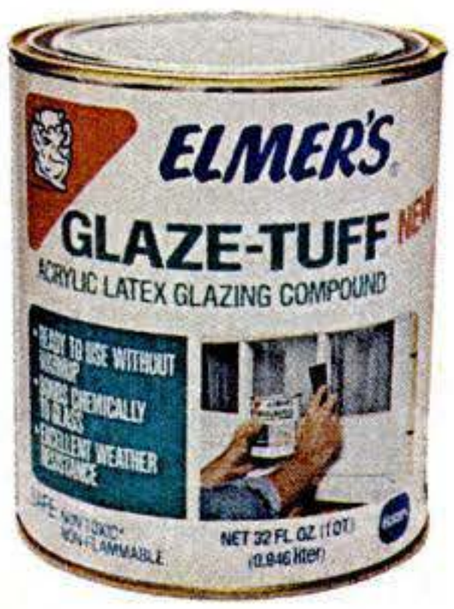
Next time out, you'll be pleasantly relieved at the end of a long day when your boat glides effortlessly onto its trailer. —*John W. Rapps*



"This new Glaze-Tuff sure puts zip into glazing." *Bernie Cohen*
Window Glazier.

Pros like Bernie Cohen are impressed with how fast Glaze-Tuff™ acrylic-latex glazing compound can be applied.

That's because Glaze-Tuff needs no warm-up and spreads on smoothly. It's ready-to-use and stays flexible all through the job. Unlike oil-based compounds, this new product bonds chemically to glass to resist cracking and weathering.



This new glazing compound is convenient and easy to apply. It cleans up easily with soap and water (before it dries). After just a half hour, you can paint over it.

Take a tip from the pros: Ask for Elmer's® Glaze-Tuff. Once you try it, you'll never use anything else.

Elmer's. When results count.

BORDEN®

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Alive with pleasure! Newport

After all, if smoking isn't a pleasure, why bother?

Warning: The Surgeon General Has Determined That Cigarette Smoking Is Dangerous to Your Health.

Box: 16 mg. "tar", 1.1 mg. nicotine; Kings: 17 mg. "tar", 1.2 mg. nicotine; 100's: 19 mg. "tar", 1.4 mg. nicotine av. per cigarette. FTC Report April 1976.

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HOUSEPOWER CLINIC

By EVAN POWELL

Energy efficiency—what's ahead

The only news from the recent National Home Appliance Conference in Louisville is that there's *no* news. Don't look for any surprising technological breakthroughs in this year's home appliances. There are some changes in trim, and wider use of styling devices such as textured surfaces, but that's about it. And there are not many more (if any) new energy-saving appliances over last year.

Most of the manufacturers' talk about energy was directed toward arriving at agreements with the government on specifying the operating costs of appliances. Since the frequency of use of appliances differs considerably (refrigerators and freezers excepted), methods of rating them must be carefully devised to offer valid comparisons.

Many home appliances were originally designed to be energy-efficient (early room air conditioners, for example)—not because energy was costly but because the wiring in our homes was often barely adequate. So, while appliances can still be made more efficient, beyond certain basic steps even small increases in efficiency come at a very high cost. And some studies show that the additional energy consumed in manufacturing will not be offset during the appliance's lifetime. Home appliances aren't likely to gain efficiency soon.

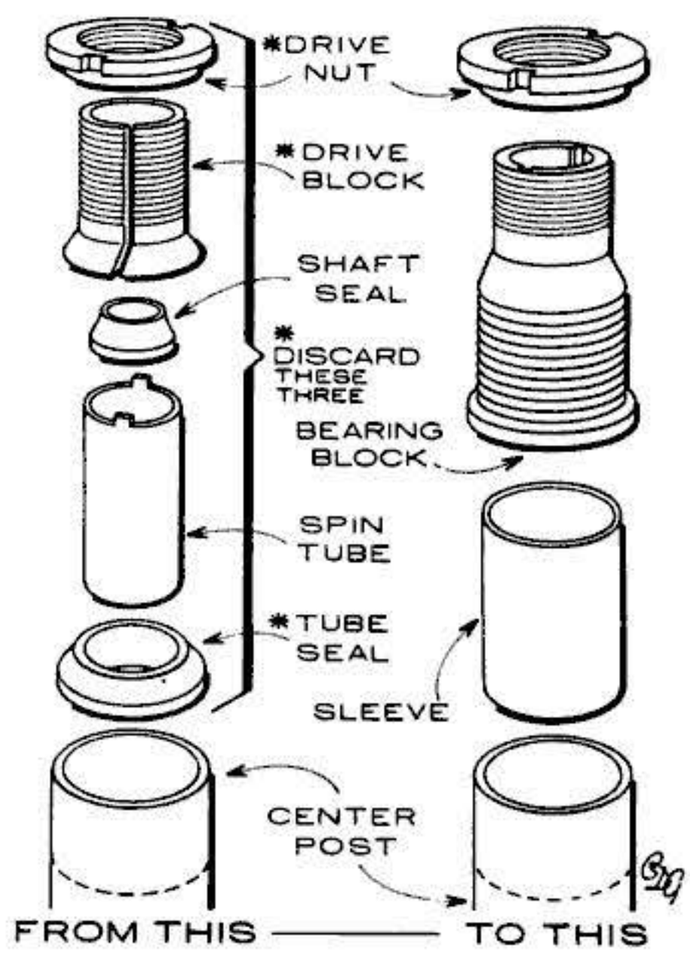
Now—a DIY bearing kit

If you own a Whirlpool or a Kenmore washer, sooner or later you're going to notice a slight knocking sound when the machine goes into the spin cycle. Over a period of months, the noise will become louder and louder.

This is a symptom of worn spin-tube bearings. The machine probably will have served a long and useful life by the time you hear it, and can continue to run for months and even years with the bearings happily pecking away. But the problem is progressive, and often involves leakage of detergent-laden water.

Until now, the only solution has been to remove the gear case and drive train, remove the old bearings with special tools, and press new ones into place. Of course, a new spin tube is necessary, since the old one would quickly erode the new bearing. Sometimes, additional wear may be found, and the result may be a rebuild job—plus a whopping bill that can run from $80 to $125.

Enter P-G Assco, a major supplier of appliance parts, with a bearing kit that



installs in less than an hour. Here's how: Remove the basket, the drive block, and upper seal. Sand a two-inch section of the center post, apply an adhesive, and slide a sleeve over the post. The bearing-block assembly next takes the place of the original upper seal and drive block, and the job is done.

If you install this kit at the first sign of worn bearings, you're likely to prevent other problems that can occur later, such as damage to the clutch facing. While a pro can do the job in 20 minutes, allow yourself 45 minutes or more. Detailed instructions are included. The kit will cost you about $15 at a parts supplier. Adhesive and a spanner wrench for the drive nut, if you need them, will add another $5. If you can't locate a supplier in your area, write to P-G Assco Corp., 11 Stepar Place, Huntington Station, N.Y. 11746. If you are concerned about the worn lower bearing that's still in place, forget it; early machines had no lower bearing, and they seemed to last just as long as newer models.

Light-sensing stat

The Therm O Guard thermostat mentioned in my December article [p. 126] has proven itself well during winter months. Since it's completely electronic, it doesn't have to be level, and there's no anticipator to adjust. I have also determined that our sample maintains more consistent temperatures than any domestic stat I have tested. A time delay installed at changeover would be the only suggested improvement.

Q&A Overflowing washer

Our Kenmore washer seems to work okay, but the water will not shut off when the machine is full. Why does it overflow onto the floor?

J. W. Gilson, Oregon, Ohio

Start the machine, then turn off the power when it is almost full. If the water stops, the problem's due to a faulty water-level switch. If it continues to flow, it's due to sand or other matter blocking the bleed holes of the inlet-valve diaphragms. To cure this, turn off the power and remove the valve (the plastic block where the inlet hoses attach). Noting the position of all parts, disassemble it and clean with a soft brush under running water. Replace the small filter screens if they are torn. You may never see the offending particle, but when you put it back together it should work like new.

Once again, combustion air

You have mentioned bringing combustion air to the furnace for hot-air furnaces, but mine is heated by an oil burner with forced hot water. What suggestions do you or your readers have for it?

Albert Sheafe, Needham, Mass.

The answer to all such questions is to bring in outside air for all combustion-type heating equipment. That includes oil burners, gas burners, and fireplaces. And it's used for the burner, not recirculating air, so it applies equally to hot-air and hot-water systems. The big advantage of an outside-air intake is that it allows you to control and direct the air. That's especially important for a fireplace —you can place an intake grille immediately in front of the hearth or to the side where the intake air flow won't be noticeable. When you elect to open a window, you are usually in the path of the cold draft.

Home food slicer

I worked in a market while in school, and now want to add a food slicer to our appliances. Because of my previous experience, I'm disappointed with the motorized models for home use that I have tried. I can't afford a $600 commercial unit. Any recommendations?

Dana Adams, Asheville, N.C.

While I know of users who are quite happy with the performance of their motorized domestic slicers, I would recommend the hand-cranked type for most families. Another alternative is to shop around for a used commercial model. Look for a good motor (listen to it run), and check for wear and play of bearings by moving the blade shaft up and down. Be sure that the blade is not badly nicked or damaged—a new one can cost $80 and up. Be prepared to disassemble it completely for cleaning, and don't attempt this on a weak stomach. You'll probably invest a total of about $100, but you can use it for ten years and it will probably still be worth as much. Disadvantages? It's heavy, and takes up a lot of counter

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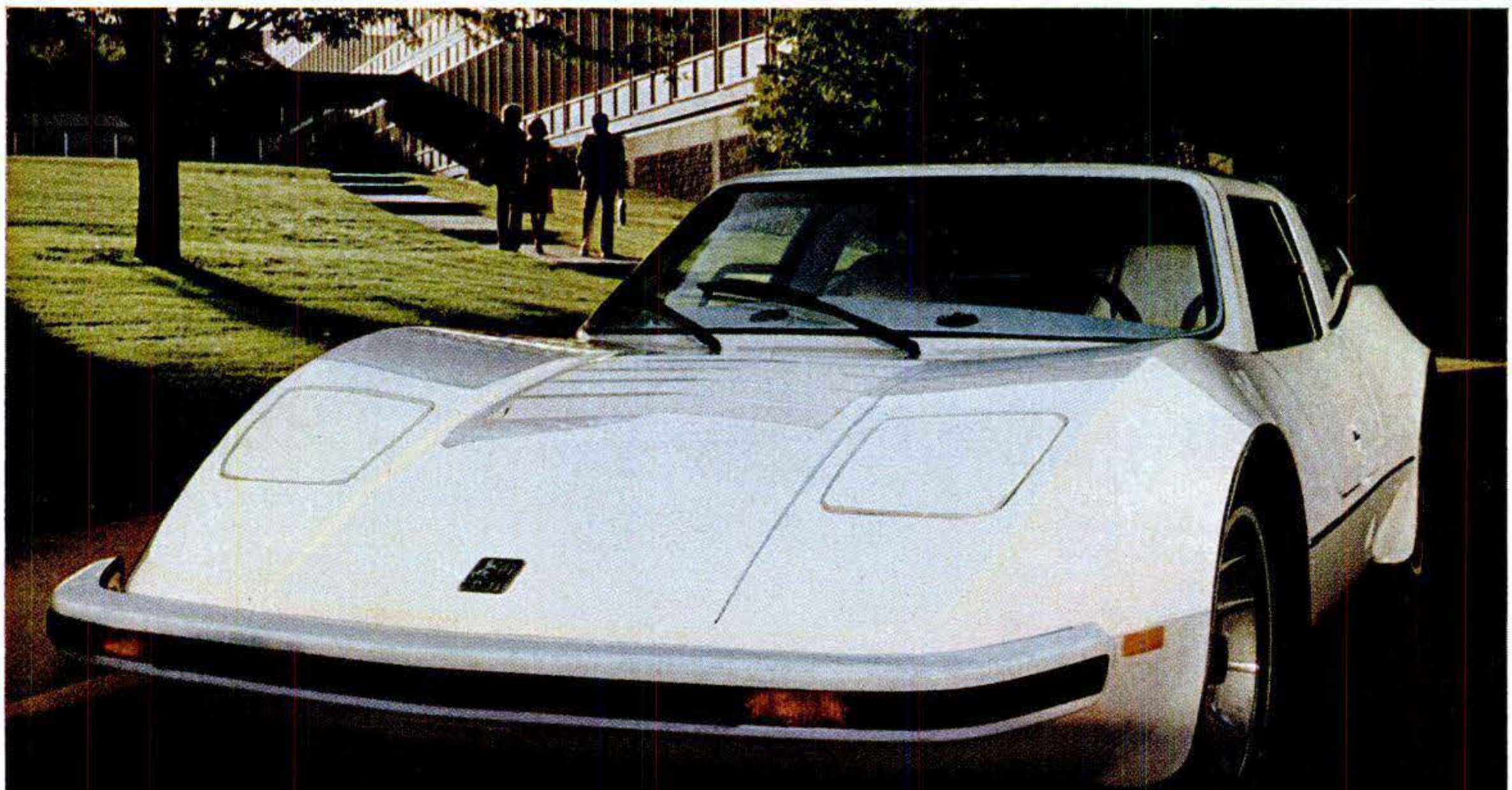


Introducing an exciting new concept in autodynamics.

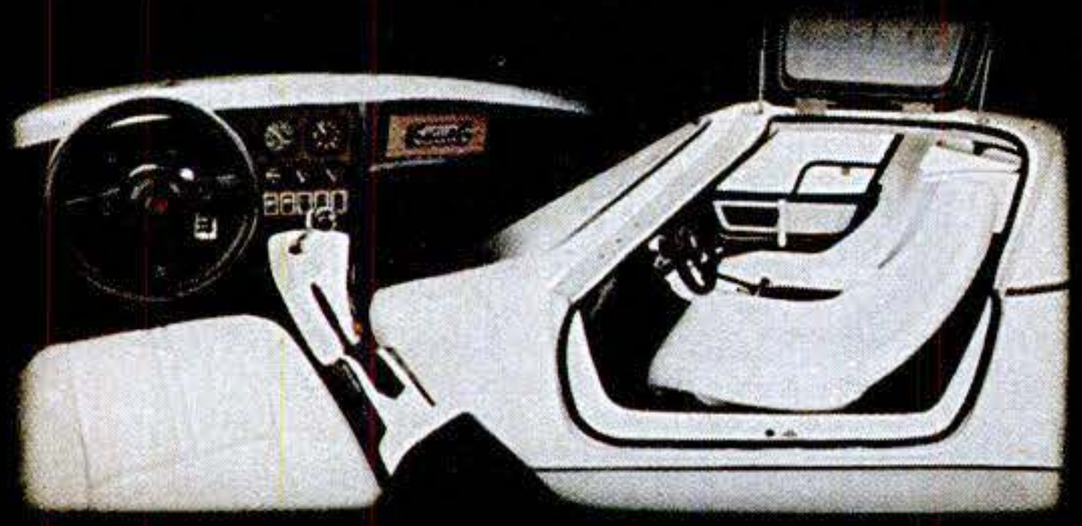
The Bradley GT II.

Nothing in the motoring world so dramatically combines the style and performance of the finest European sportscars with the economy and dependability of a VW. Each component of the GT II car kit is custom-designed for precision fit and easy assembly on a Volkswagen chassis. The totally-engineered, finely-crafted finished product is a reflection of your own good taste and individuality. A product with unique autodynamic properties that provide significantly improved performance. And with styling so reminiscent of the most expensive and lavish European sportscars.

Its many amenities include fiberglass gull-wing doors and hatchback rear door. A steel reinforced roof and fiberglass body. Tinted safety glass windows. European-styled instrument cluster. Electrically-powered pop-up headlamps. And so much more.

The all-new Bradley GT II car kit. An exciting new concept in autodynamics. Available in a choice of beautiful colors, all with color coordinated interior.

Send $1.00 for the 4/color Bradley brochure, write Bradley, 495 Shelard Plaza, 400 County Road 18 South, Minneapolis, Minnesota 55426.



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PS-2

BRADLEY AUTOMOTIVE

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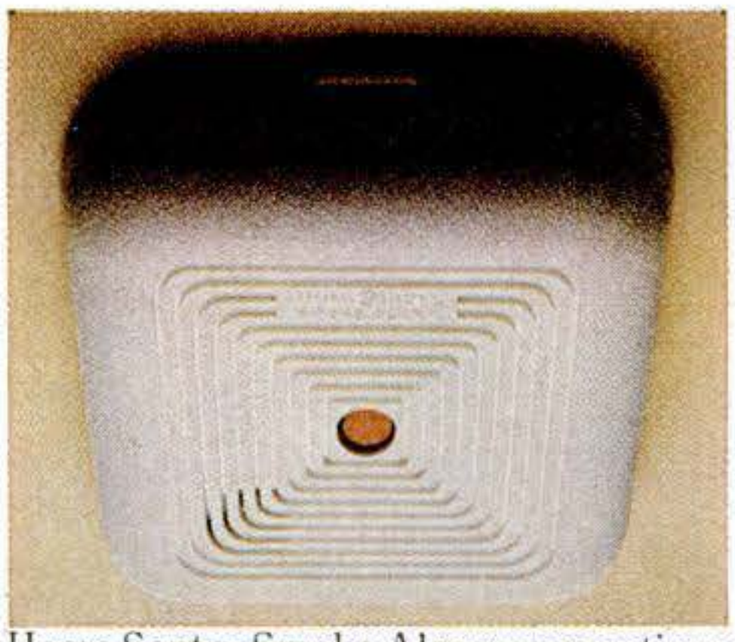
Deciding which smoke alarm to buy could be one of your most important decisions. Here's why more families are choosing the Home Sentry® Smoke Alarm from GE than any other.

The Home Sentry Smoke Alarm from GE is an early-warning system that "sniffs" the air for the presence of smoke and sounds an alarm when smoke reaches it. Here are some of the reasons more families depend on the Home Sentry Smoke Alarm than any other smoke alarm.

The battery-operated Home Sentry Smoke Alarm is the *only* smoke alarm with a 3-point checking system to assure you the alarm and the entire system are in working order. It features a 12.6-volt Duracell® battery made especially for smoke alarms by P. R. Mallory & Co. Inc. And because it's battery-operated, the



Home Sentry Smoke Alarm can continue to function even if household power fails.

Of course, there's no way to guarantee against injury or loss of life in a fire; however, the Home Sentry Smoke Alarm from GE is intended to help reduce the risk of tragedy. And every Home Sentry Smoke Alarm is backed by the General Electric name and the quality and reliability it stands for.

The Home Sentry Smoke Alarm is compact and easy to install with common household tools. For more details and a demonstration, see your local GE dealer. Now's the time to buy one—or as many as your home may need. The Home Sentry Smoke Alarm could help you save your home and your family's lives.

GENERAL ELECTRIC

Housepower clinic

[*Continued*]

space. But that paper-thin roast beef makes it all worthwhile.

Filter resistance

I read with interest your article in the October issue [p. 118] about high-efficiency filters, and am very interested in exploring the possibilities of their use on my furnace and air conditioner.

When I checked with my heating-and-air-conditioning contractor (in whom I have much confidence), he told me that a product like Space-Gard would reduce air flow to the point of overloading the fan motor. Could you give me any specific figures?

Richard Dyas, Eagle Grove, Ia.

The multi-pleated construction of the Space-Gard spreads air flow over a very large area, equivalent to more than 78 square feet of filtering surface. This method of construction tends to lower the resistance of the filter. Remember, too, the other means of accomplishing filtration pointed out in the story. It's the design of the filter, not "tightening" of the media, that counts.

In each of the samples I used in researching the story, I checked the resistance with an inclined manometer. I found no significant difference between these and ordinary panel filters. As to specifics, the Space-Gard resistance (in inches of water column) is listed at 0.05 at 600 cfm, 0.1 inches at 1000 cfm. The E-Z Kleen is listed at 0.020 at a velocity of 200 feet per minute, and the Johnson FM2000 at 0.075 at 200 fpm.

Unless your air system is really borderline, high-efficiency filters should make no significant difference in air flow. After years of using nothing else, I have experienced no difficulties whatever. I do find that the blower compartment, the heat exchanger of the furnace, the evaporator coil of the air conditioner, and all ducts are completely free of lint and debris.

Finding furnace filters

It's come to my attention that many PS readers have received confusing replies to their inquiries about high-efficiency filters from two manufacturers listed on page 174 in my October article.

Neither of these companies—Flanders or Cambridge—replied to our original letters when we were researching the story. That's why you don't find their products mentioned in my text. But since they are major manufacturers in this field, both were contacted by telephone when the listing of manufacturers was compiled.

In a form-letter response to reader inquiries, a Flanders Filters representative goes into detail about two points: HEPA filters are too expensive for home use, and several standards are used to evaluate filter efficiency. Both are points already covered in my article. When we'd contacted Flanders previously, we didn't even discuss HEPA filters, but were told —by a different rep than the one who signs the form letter—that Flanders would forward information about other high-efficiency filters in its line that could be adapted to home use. Obviously, this word wasn't passed along at Flanders.

When we'd phoned Cambridge about the listing, we were again told that some of their high-efficiency filters could be adapted for home use, and the company felt it should be listed. I agreed: Both of these companies were included because they manufacture quality products and are leaders in the development of high-efficiency filters.

But it now appears that it will do you no good to query them unless you're interested in a true HEPA filter for commercial installation. On the other hand, we have reports that several of the other companies listed are according PS readers special courtesy.

Residential applications are virgin territory for high-efficiency filters, and you'll have to ferret them out. It's well worth the effort—it can cost little to increase the efficiency of your present filters many times over. PS

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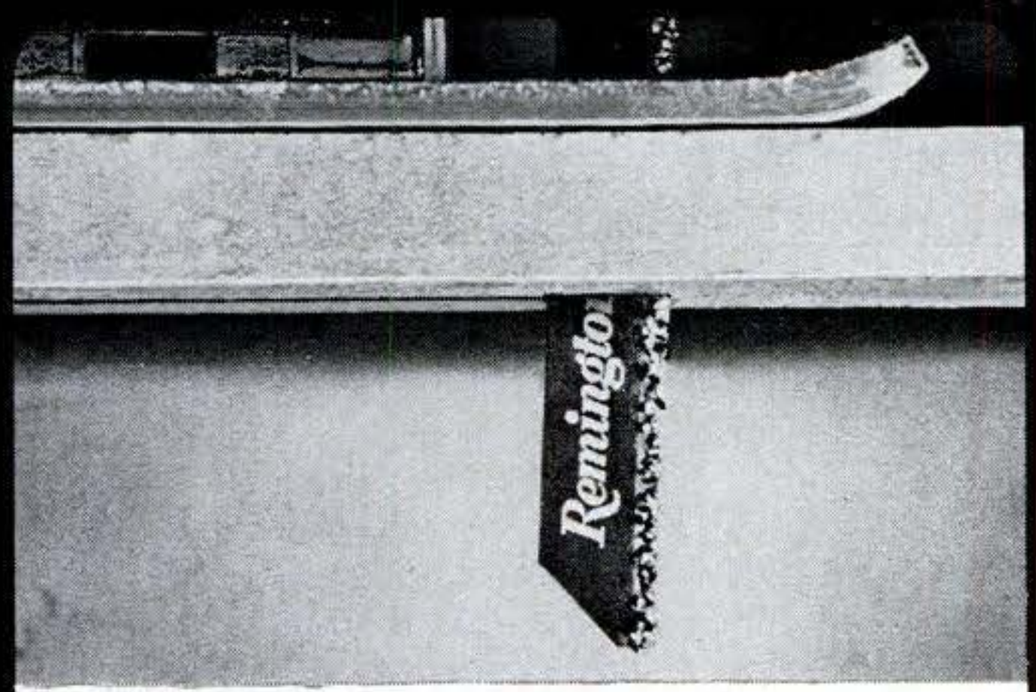
"Grit-Edge" blades saw asbestos-cement.



Remington "Grit-Edge" saber saw blades make contour cuts in asbestos-cement, fiberglass, synthetic marble and plenty of the other "unsawables".

Tungsten carbide particles permanently bonded to steel make "Grit-Edge" blades just the cutting tools to saw hard and brittle materials with a smooth-edge finish.

Economical, durable "Grit-Edge" blades. Tough enough to take on almost anything.

For more information, see your hardware dealer or write: Abrasive Products, Dept. 649, Remington Arms Company, Inc., Bridgeport, Conn. 06602.

GRIT EDGE When ordinary blades can't cut it. **Remington** DUPONT

"Grit-Edge" is a trademark registered in the U.S. Patent Office.
"Remington" is a trademark of the Remington Arms Company, Inc.

"Grit-Edge" blades can cut it.

Material	Rod Saw	Hack Saw	Saber Saw	Circ. Saw	Band Saw
Asbestos-Cement	X	X	X	X	X
Beryllium	X	X			X
Carbon	X	X		X	X
Cast Iron	X	X			X
Composites	X	X	X		X
Composition Board			X	X	X
Fiberglass	X	X	X	X	X
Foamed Glass	X	X			X
Friction Materials	X	X	X	X	X
Glass	X	X			X
Hardened Steel	X	X			X
Honeycomb Materials					X
Marble, Natural	X	X	X		X
Marble, Synthetic	X	X	X	X	X
Plaster			X	X	
Plastic Laminates	X	X	X	X	X
Plywood			X	X	X
Stainless Steel	X	X	X*		X
Stranded Cable	X	X			X
Superalloys, Iron-base	X	X			X
Superalloys, Nickel-base	X	X			X
Tempered Hardboard			X	X	X
Tires, Steel-reinforced					X
Titanium	X	X			X
Tile, Ceramic	X	X	X		X

*Requires coolant and variable – speed machine

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"Grit-Edge" blades fly through fiberglass.

Remington "Grit-Edge" circular saw blades fly through fiberglass, composition board, plastic laminates and plenty of the other "unsawables".

"Grit-Edge" blades have no teeth to snag, dull or break. And they never need resharpening. Yet their cost is surprisingly reasonable.

Economical, durable "Grit Edge" blades take over when the going gets tough.

For more information, see your hardware dealer or write: Abrasive Products, Dept. 648, Remington Arms Company, Inc., Bridgeport, Conn. 06602.

GRIT EDGE When ordinary blades can't cut it. **Remington** DUPONT

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"Grit-Edge" blades trim tile with style.

Remington "Grit-Edge" rod saw and hacksaw blades make contour cuts in ceramic tile, snag-free cuts in high-pressure hose, cuts at any angle in hardened steel, space-age alloys and plenty of the other "unsawables".

Hundreds of tungsten carbide particles permanently bonded to "Grit-Edge" blades make them a match for materials conventional blades can't tackle.

Economical, durable "Grit-Edge" blades take the tough out of tough jobs.

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[Continued from page 86]

beam, focused to a one-micron spot, strikes the bottom surface of the aluminum disc (see diagram). This highly reflective layer has a clear-plastic protective coating. The beam falls on a spiral track that consists of oblong bumps of varying lengths, with flat areas between them. The encoded picture information varies the distance between bumps. Part of the laser light is reflected from the flat area between bumps back through the optics to a light-sensitive diode that detects the TV signal. Only one side of a disc is programmed, with 30 minutes of material.

By shifting the beam spot slightly on the spinning disc, three sophisticated servo circuits maintain focus, tracking, and proper speed. The servos sense deviations by monitoring auxiliary beams reflected from the disc. Corrections are made with electronic signals that can shift the focusing lens up or down; or, to compensate for radial (sideway) and speed errors, two mirrors positioned at right angles to each other can be pivoted to shift the beam spot.

Jolting a player

Despite the extraordinarily small tolerances involved, the servos do their jobs remarkably well. Even a sharp rap on the Philips/MCA player case—enough to jolt an audio-cartridge stylus from its groove—does nothing, or produces only a brief flicker on the picture.

Philips/MCA discs can be handled easily without concern for smudges or dust. The thick protective coating keeps blemishes out of focus, which prevents picture interference. Discs should last indefinitely, since there's no wear from playback. The helium-neon laser "stylus" lasts a minimum of 10,000 hours before replacement may become necessary.

There's a distinct look and feel of compact precision to the Philips/MCA player. The front panel is packed with controls that capitalize on the contactless readout and the fact that each revolution of the disc produces one TV picture.

One button lets you indefinitely freeze any one of 54,000 picture frames for in-depth viewing on the screen. Other controls enable you to advance the picture sequence manually, frame by frame, forward or backward. A variable-speed control does the same thing automatically.

Counting frames

In the fast-scan mode, pictures become a blur; however, every few seconds one is frozen for an instant to help pinpoint a location. All Philips/MCA discs will be encoded with signals that serve to identify each frame. Tap another button and the frame numbers appear in a corner of the TV screen. The player has stereo hi-fi output jacks and a video-output jack (a non-RF signal).

Both RCA and Philips/MCA have invested perhaps several hundred million dollars without knowing whether consumers will buy the players and discs to program their own shows. If the spectacular climb in sales of video-cassette recorders, TV-game, and pay-cable systems are any indication, the video-disc manufacturers have made a shrewd investment. PS

Focus in on Kmart's Camera Department for KODAK cameras and film.

Your Kmart Camera Department has low, discount prices on KODAK Instamatic® cameras... like the KODAK Tele-Instamatic™ 608 color outfit, the KODAK Trimlite® 18 camera and the KODAK Instamatic X-15 color outfit. And film? You'll find a wide selection of KODAK film for any popular-size camera. Picture Kmart for your camera, film and processing needs... where the focus is always on value and quality.

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The metal rule that comes out of its case versus the wood rule.

Stanley has always made a fine folding wood rule. But now we think there's a better case for the rule that comes out of its case – Stanley's new Extender™ Rule.

For instance, any extended zigzag rule will sag – while the Extender remains rigid. And there's the price difference – $6.50 versus $3.25. Plus a lot more to think about.

Just compare them. You'll probably agree that, after all these years, there is a better idea than the folding wood rule.

Compare them for yourself:	Extender™ rules	Folding wood rule
Length	6'6"/2 Meter or in all English 8'	6 feet
Width	1"-wide blade – Stanley exclusive	⅝" – fits in narrower places
Rigidity	Remains rigid for 7' without sagging	Sags at about 3' when unsupported
Size	Compact 3" case slips into any pocket	Bulky 8" length needs deep pocket
Extension	Pulls out, pushes in like ordinary rule	Fold or unfold up to 11 joints
Durability	Strength of 1"-wide steel	Stick may crack
Scale	Inches one edge, metric other. (8' rule has inches left to right *and* right to left. Also a running ft.-in. scale.)	Inches only left to right
Marking Accuracy	Graduations lie flat to surface of work	Graduations appear approx. ⅛" above work
Finish	DuPont Mylar® polyester film – resists oil, abrasion, dirt, most solvents	Lacquer – less durable than Mylar
Hook	Allows outside as well as inside reading	Inside reading made with extension slide
Price	About *$3.25*	About *$6.50*

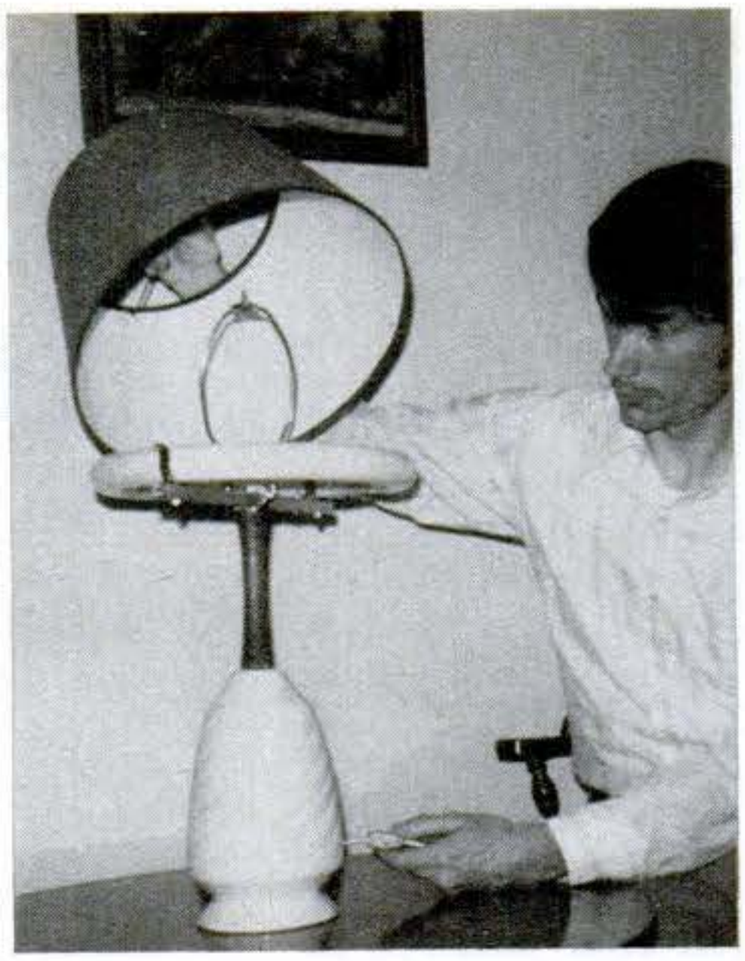
STANLEY®

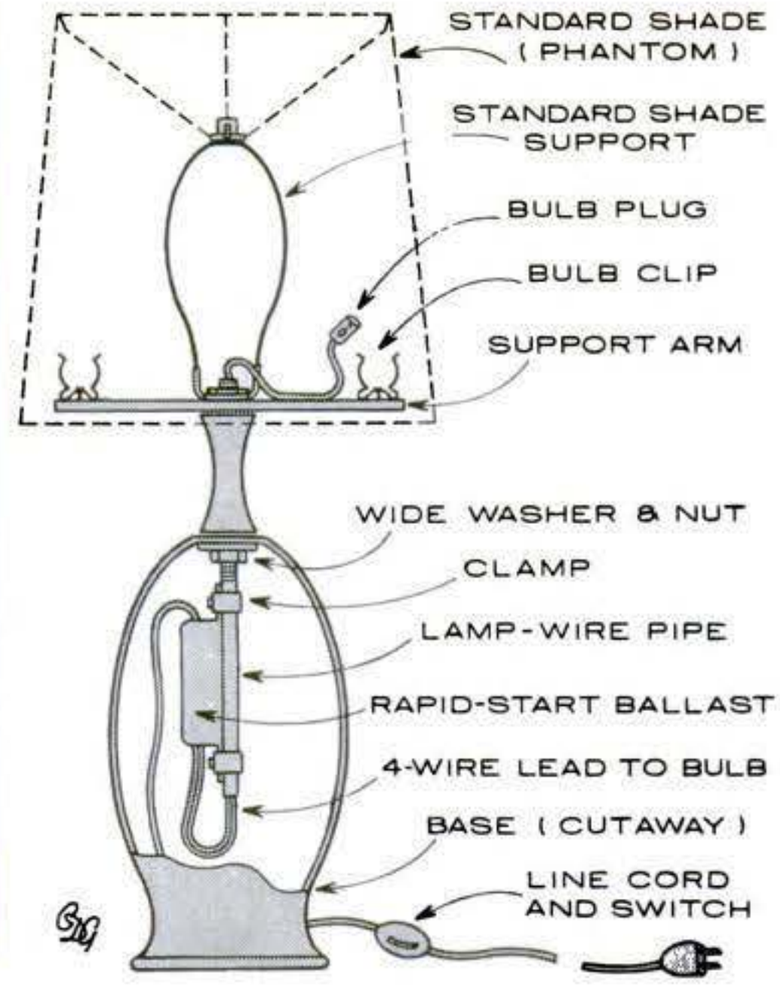
helps you do things right.

Incandescent to fluorescent **lamp conversion**

Like to keep a light on all evening or all night? For any use of more than three hours, fluorescents are more economical than incandescents (see table). Here's a way to combine this economy with the appeal of an incandescent table lamp.

A 32/40-watt rapid-start P-type ballast goes inside the lamp base—metal electric-cable clamps are ideal for attaching it to the lamp wire pipe. Replace the incandescent-bulb socket and switch with a 32- or 40-watt circular fluorescent lamp. Make the support arm of metal, which grounds the lamp and aids starting. You can saw off rigid-metal flat stock or aluminum wall-shelving standard: 13 in. for the 32-watt lamp, 17 in. for the 40. Drill a ⅜-in. hole through the arm center and mount it on the lamp-wire pipe. Metal clips—for tool handles—hold ends of bulb.—*Peter Eisenhut*

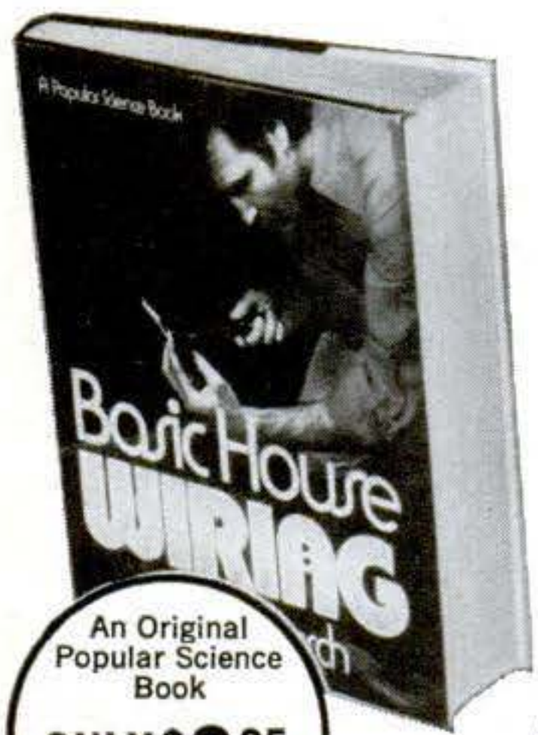




Conversion cost $12, excluding fluorescent lamp, which pays for itself in longer life. Table shows fluorescents can last more than seven times as long as incandescents, using less than one-third their power, and give about the same light output. Run a four-wire (18 ga.) lead to the lamp, connect as necessary with crimped splice or butt connectors. Use a line-cord switch, and be sure that all wiring is insulated.

Power required for equivalent light output

	Fluorescent (32-watt circular)	Incandescent (100-watt soft)	Incandescent (two 60-watts soft)
Life (hours)	7500	750	1000
Light (lumens)	1790	1710	1710
Power (watts)	32	100	120



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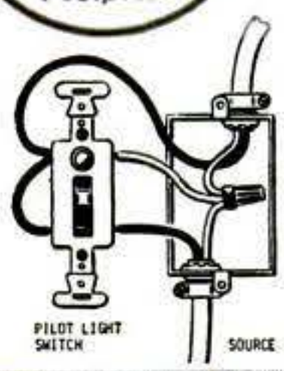
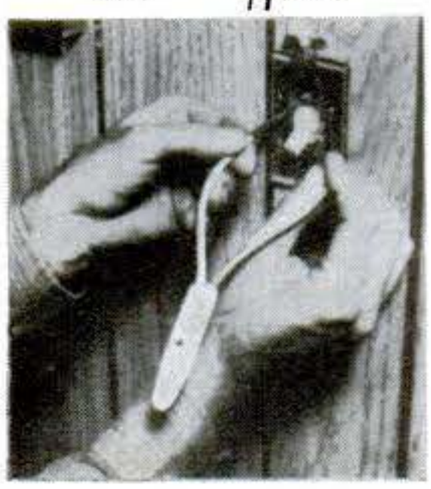
Basic House WIRING

By Monte Burch





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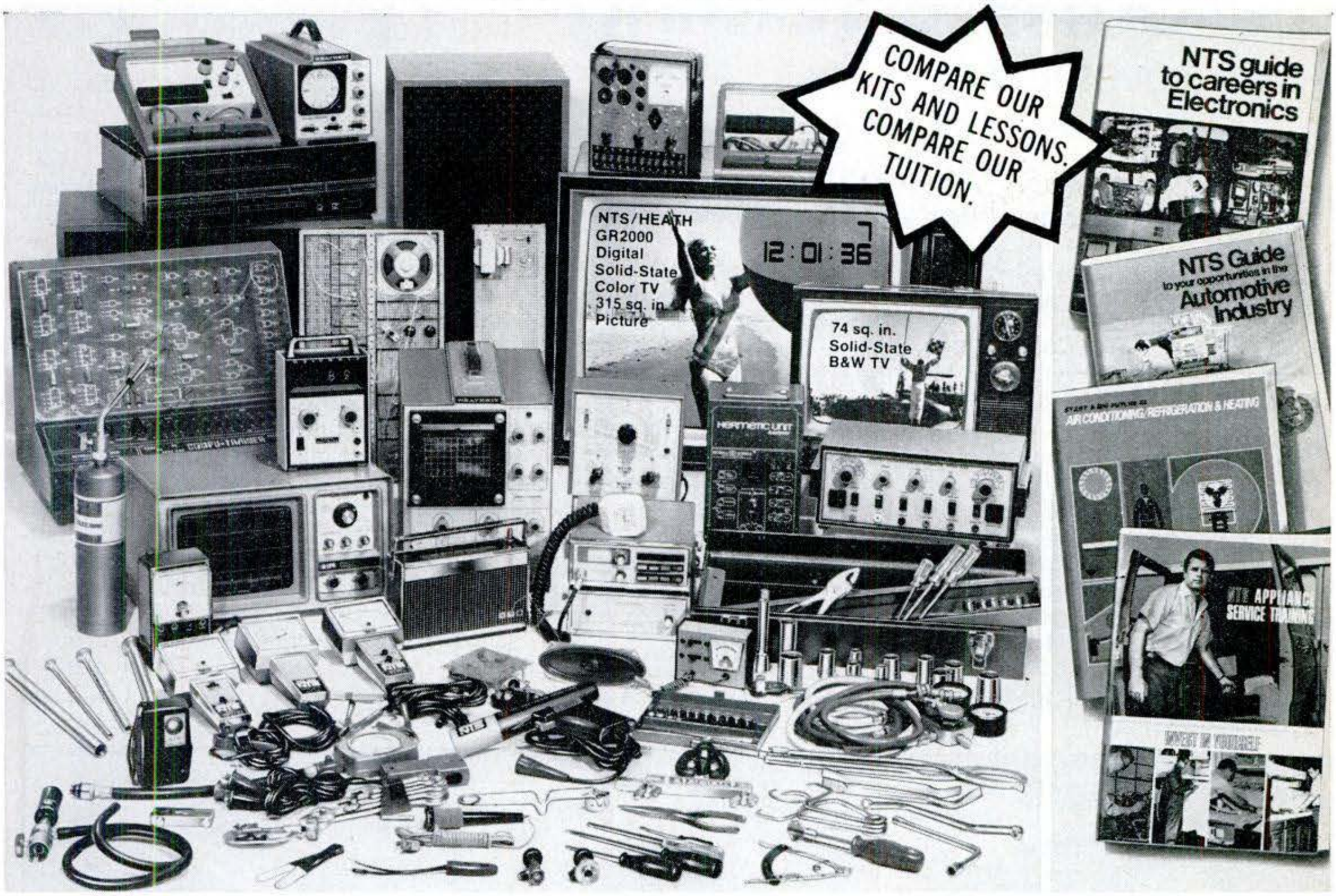

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New proof that **outside venting** saves fuel

Tests show outside venting improves furnace efficiency. You cash in on fuel savings

By EVAN POWELL

When I first suggested outside venting [PS, Oct. '73], it was only one of many ideas for improving furnace performance and operating economy—but one that I soon learned most readers were unaware of. Reader interest prompted PS this year to offer several methods of providing combustion air [PS, Feb.]. But many PS readers still wonder whether the fuel savings justify the expense of installing an air intake. Recent findings provide some answers.

Why bring in outside air, anyway? Any heating system with an open flame needs huge amounts of air to provide oxygen for the burning process and to control draft in the flue and chimney. This air is drawn through the burner opening and the draft regulator, then evacuated, along with flue gases, up the chimney. All of this air must be continuously replaced.

Normally, makeup air comes from seepage around doors, windows, and other structural openings. But such infiltration of cold air puts an additional heating load on the furnace. To avoid this, many of us have buttoned up our homes, insulating any openings where air seeps in. This does conserve fuel, but creates another problem: Furnace efficiency is reduced by suffocation of the flame, which, in extreme cases, may be dangerous.

The obvious solution is to vent in outside air—but do the energy savings justify the expense? Lennox Industries (P.O. Box 250, Marshalltown, Ia., 50158) has just completed a test program which, for the first time, defines outside infiltration losses. Lennox built a hermetically sealed room, and tested two sizes of residential oil furnaces. The smaller furnace was fired with a 0.65-gallon-per-hour nozzle, the larger with a 1.2-gph nozzle.

Both furnaces were adjusted with combustion test instruments to reproduce good installation conditions. Two series of tests were run on each furnace, using both a 13-foot-high stack and a 20-foot-high stack. For each test, the furnace was installed in the center of the sealed room. Return-air and warm-air ducts, all completely sealed against

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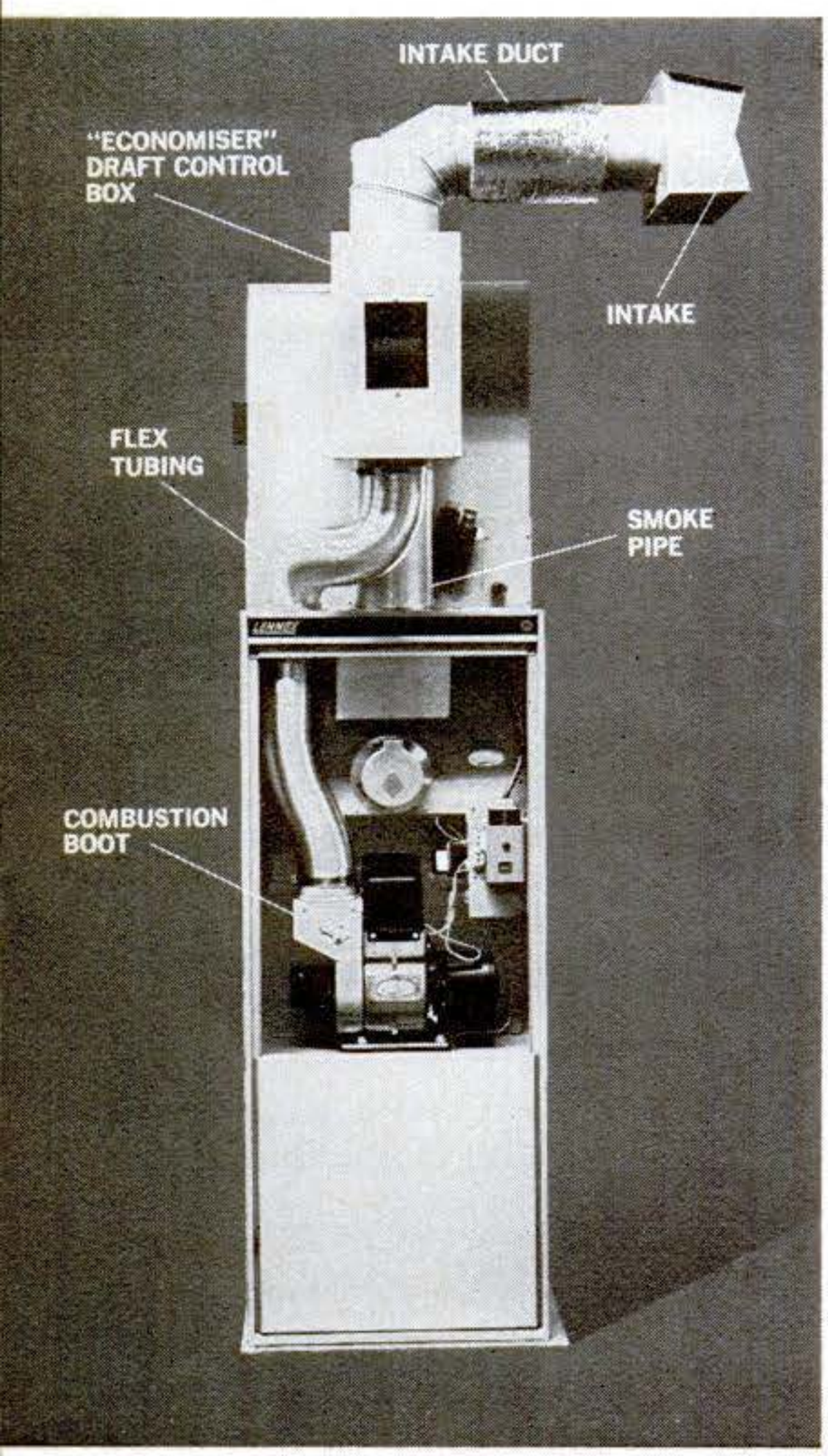

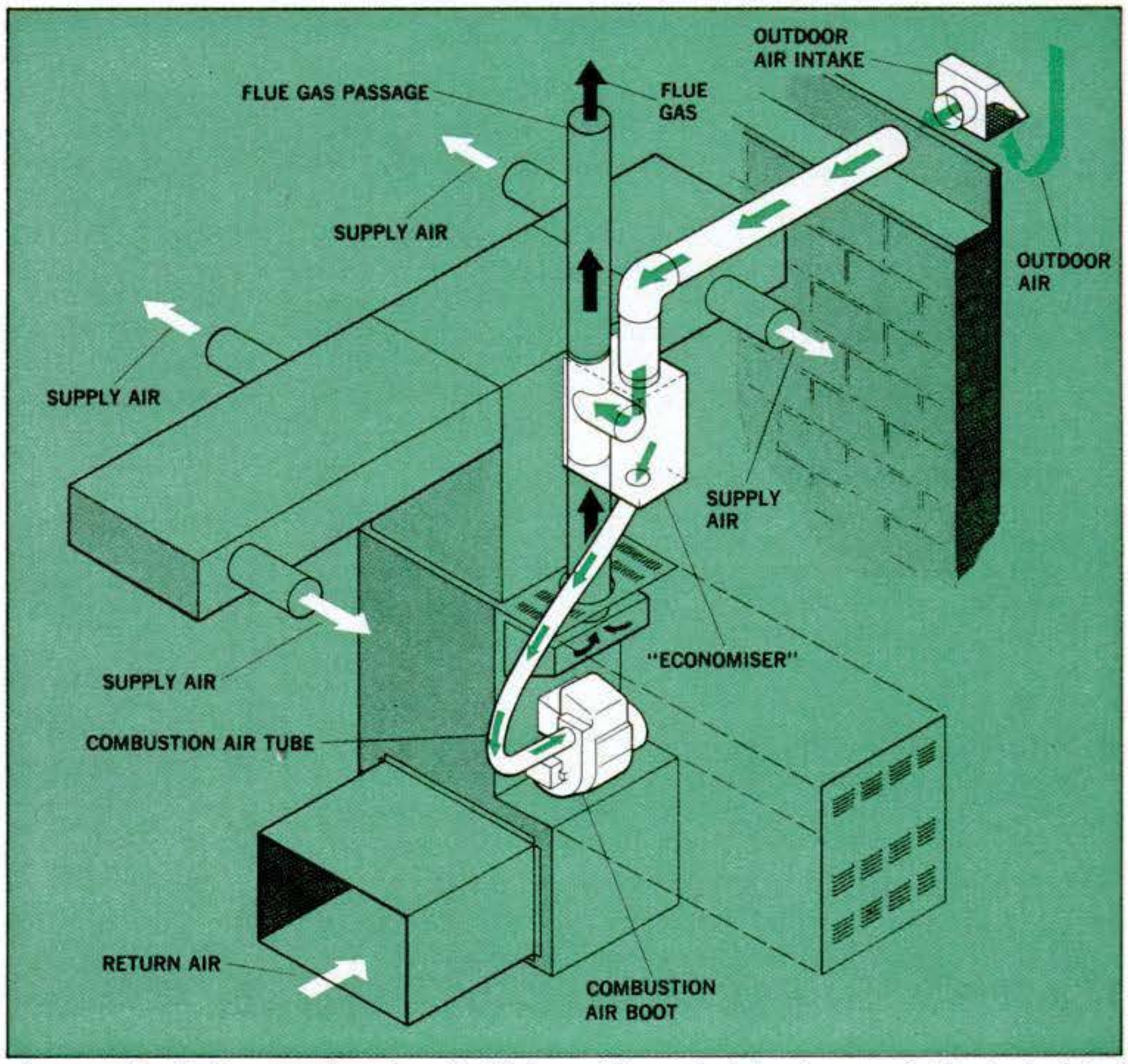

Lennox Fuelmiser system is retrofit to furnace (left). Diagram shows how this sealed combustion-air system allows heated air to circulate in a closed loop. Air vented in from outside is isolated from warmed air supplied to living area; return air is reheated by furnace then recirculated throughout the house.

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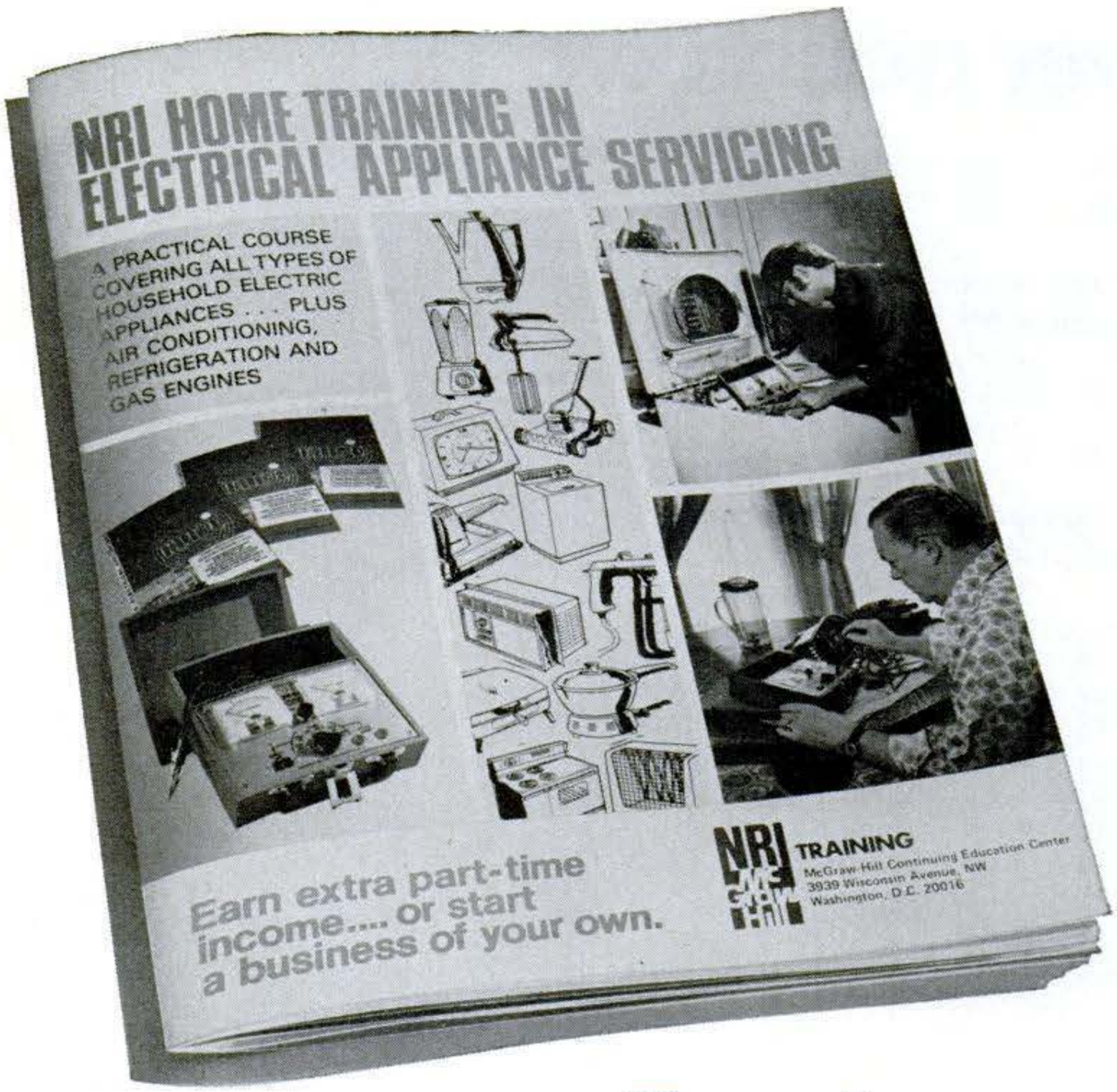

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air leakage, extended through the walls.

A miniature wind tunnel introduced air into the test room. The actual amount of air being used by the burner and the barometric damper was recorded, along with its temperature, barometric pressure, and relative humidity. Each furnace was run through three operating cycles, at rates varying from 16- to 100-percent load (continuous operation).

After computing the actual volume of air used by the furnace, Lennox technicians determined how much of the furnace heat was used to warm this air. They added in the extra heat needed to humidify the infiltrated air. The final conclusion: At an outdoor temperature of 35° F, eight percent of the furnace's heat is used to warm infiltrated air; at 0° outside, heat load on the furnace rises to 10 percent.

To eliminate these heat losses, Lennox developed the Fuelmiser sealed combustion system. Designed for use as a retrofit, the system consists of a duct to vent in outside air, which then passes through an "economiser." This encloses the barometric draft control, so the chimney is regulated by outside air instead of by air you've paid to heat. Flexible metal tubing (for ease of installation) feeds the outside air from the "economiser" down to the combustion air boot. This sealed chamber replaces the inlet-air opening to the burner.

The Fuelmiser is in the final stage of extensive field tests; production plans depend on the results. No one can say exactly how much each of us would benefit by installing this system, since home conditions vary widely. But according to the Lennox tests, a sealed combustion-air-intake system on a new or existing oil-fired furnace should reduce fuel consumption by at least five percent and, in some cases, up to 15 percent. At present projected prices (about $120, installed), the payback period should be within one or two years. And, since the Lennox test results apply to a well-designed, properly installed furnace, the potential savings from fitting the Fuelmiser to older, air-gulping units could be even greater.

The Lennox system is not the only way to do the job. But a package system removes the guesswork. And this is the best-designed equipment that I've seen. PS

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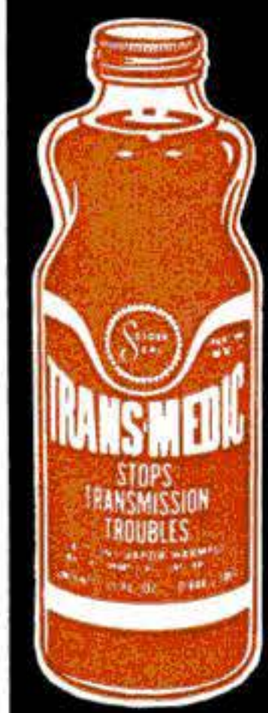

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Hot-rod sailing

[*Continued fom page 111*]

of little more than 10 knots, no matter how hard the wind blows.

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What makes the cats scat?

There are a number of reasons:

• Modern cats are very light. Good ones, 12 feet long, will weigh only 150 pounds. Even a Tornado with two 20-foot, knifelike hulls weighs only 300 pounds. Result: They displace less water, have little drag. The fastest types (Tornado, Nacra, Sol) have round sterns, so they skim across the surface of the water. This reduces drag even more. Finally, a knowledgeable catamaran skipper learns to "fly a hull" properly, lifting the windward one up scant inches from the water surface, while skipper and crew, wearing harnesses connected to the mast by trapeze wires, lean out to windward. This reduces friction even more and also reduces the amount of wave resistance, because only one hull is now slicing through the water.

• The extremely thin bows and rounded sterns of modern cats slice through waves rather than lift over them. This minimizes drag, and reduces "hobbyhorsing," the slowing action caused by the entire rig rocking fore and aft.

• The newest hull designs also have squared tips rather than gracefully rounded ones, giving the advantage of a longer water line, which is what maximum boat speed is based on. Depending on the amount of sail power, cats can even exceed the maximum hull speed of an equally long monohull.

• Moving the mast and most of the weight far back from the bows to eliminate pitchpoling also gives reserve buoyancy. As a result the leeward hull can often be completely buried in a wave and continue to drive through the water with no noticeable slowing down.

• The fully battened sails on modern cats give the skipper sophisticated shape control. Sails can be shaped with deep curves for light downwind sailing, or, in high winds, be pulled down relatively flat to reduce wind spillage at the top. The new rotating masts also allow the skipper to control the direction of the sail to get the best use of the wind.

• The two hulls provide a broad, stable platform so the sail is almost always quite upright, much more so than that of a monohull, which tilts and spills wind and power with each puff. The harnesses worn by crew and skipper let them stand out to windward, providing even more balancing weight against strong winds.

• The newest hull designs have a small rocker shape on the bottom of each hull, longitudinally toward the stern. It works much like rounded blades on figure skates, which are easier to turn than the long straight blades of racing skates. Besides making for easy turning, the rocker also tends to keep the stern high in the water at speed, reducing wetted surface and water suction.

• New designs for daggerboards and rudders also aid speed. Good ones, like those on Nacra and Sol cats, are long and narrow, like glider wings. This gives them much more lift than the same square-inch area of a shorter, wider dagger or rudder.

Skillful sailing

As you may have guessed by now, cat sailors must master some special tricks. One is how best to use apparent wind—the combination of true wind and the wind generated by the boat's forward movement.

As the cat speed builds up, the apparent wind keeps moving forward. If the skipper is skillful enough to keep his boat "in the groove," he can build up enough speed so that the cat actually moves faster than the true wind.

Something else cat sailors must learn: When the wind is directly broadside and the hull starts lifting in a sudden puff, don't head upwind —instead, you must bear off to keep the boat from tipping.

Another problem for beginners: Light cats may be hard to tack in strong raise. The easiest way is to let the jib backwind and pull the bows around. At the same time, let the mainsail free so that it doesn't try to head the boat directly into the wind. When bows have swung about, pull the jib around, sheet the main in tight, and establish the correct heading. Tacking this way will prevent "falling into irons," where the cat, instead of coming about, starts moving backwards. If this happens, reverse rudders and use the backing speed to bring the boat about in the water.

These are lessons worth learning early and in open areas, rather than the hard way, in crowded harbors. Most cats accelerate very quickly, and sailing them well takes a crew with fast reactions: That's what makes any hot-rod sport such exciting fun. PS

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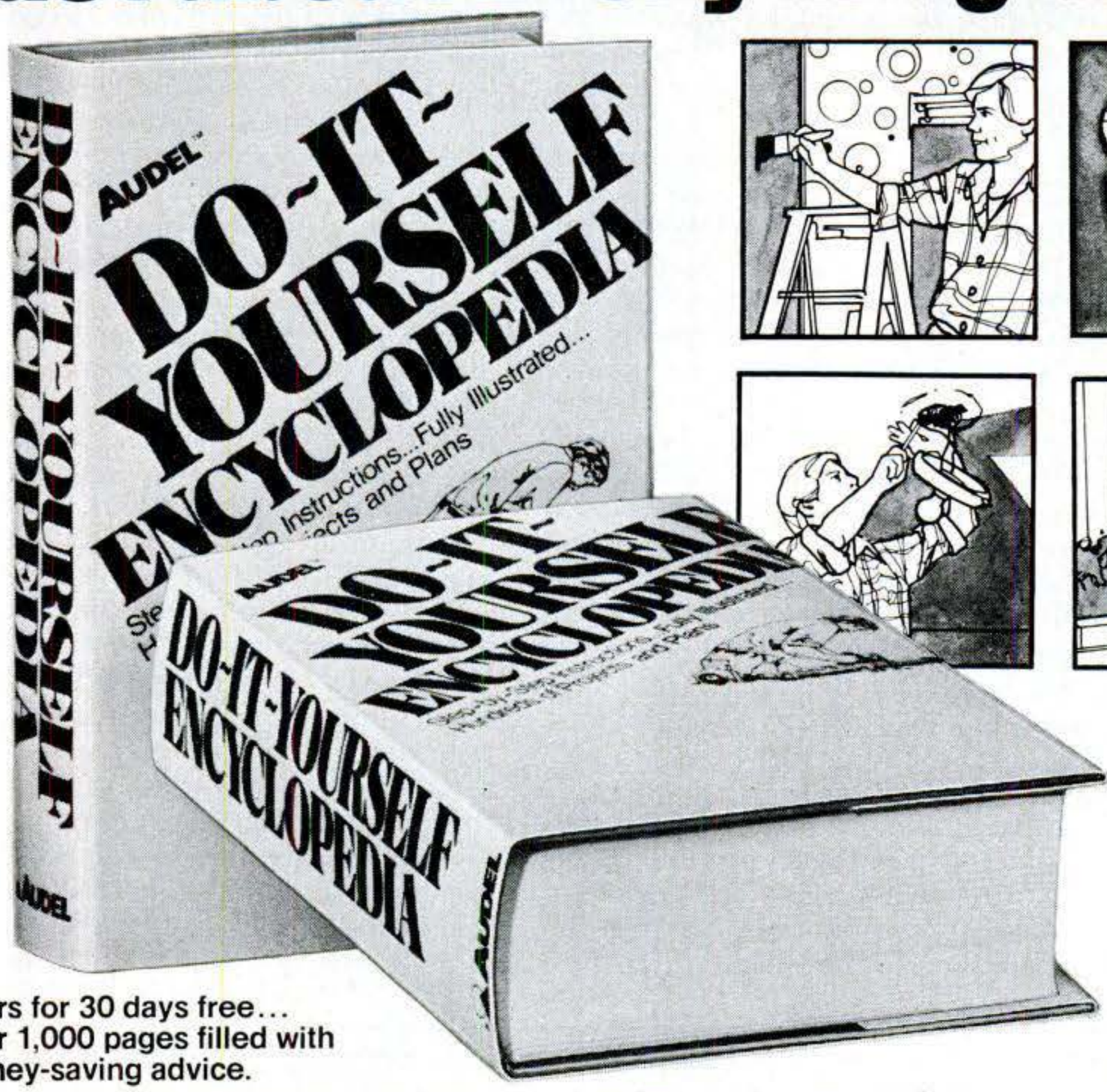

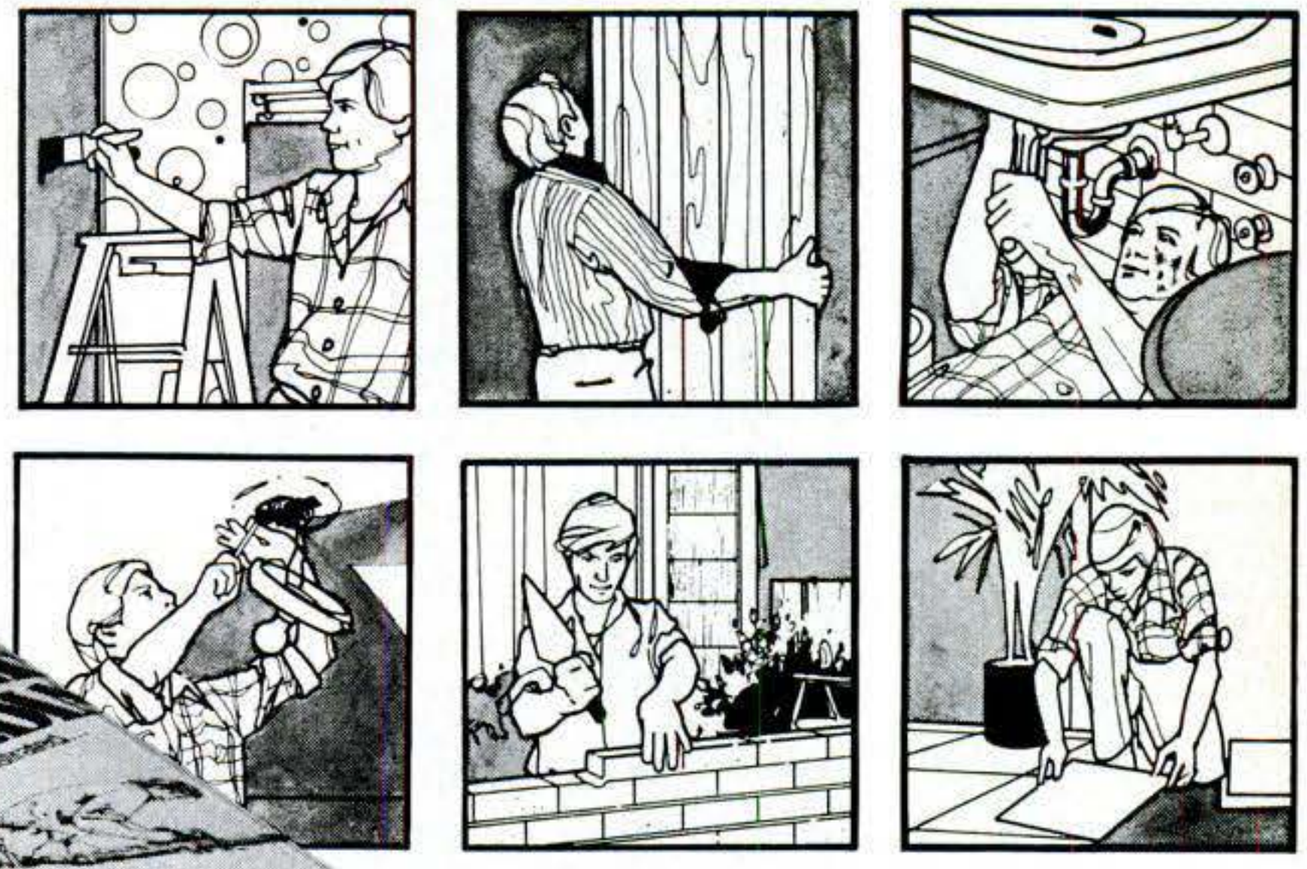

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[Continued from page 84]

have fins that make it three inches wide in cross section. The tubing is set in a frame, with each tube properly angled toward the sun. And since it takes only low-grade heat to warm the methanol solution and melt some of the ice, no glazing is needed. Westinghouse and Oak Ridge people were both involved in designing the collector.

The lack of glazing reduces construction cost, and more importantly, it lets the collector be used as a radiator to reject heat in the summer. The cost of such a simple collector/radiator isn't great. "We probably put that up for less than $120," Jim Wilds, a technician at Westinghouse, told me.

The economics of ACES

Before they built any hardware, Harry Fischer and his colleagues at Oak Ridge did a paper case study of a theoretical ACES. "We got utility bills from 406 apartments in the Washington, D. C. area," said Moyers. "Then we superimposed an ACES on paper against that project." Findings: a projected energy saving of about 75 percent over an all-electric system, and about 55 percent over a gas system.

But as with all alternate-energy systems, it costs a lot more to install an ACES than it does to put in a conventional system. Just how much more is hard to say, because ACES is still experimental. "A resistance-heating-plus-central-air-conditioning system would run about $2000 for a 2000-square-foot house," says Moyers. "With an ACES, the cost would probably run about $5400." Assuming you've got a 20-year mortgage at nine percent interest, and including payments for the extra first cost, Fischer figures an ACES will break even with electric-resistance heating and electric air conditioning by the end of the mortgage period wherever electricity costs at least 3.5 cents per kwh. (In the New York City area, it's eight cents per kwh.)

Plate ice maker

One problem with an ACES is that as winter progresses and ice builds up around the coils in the water tank, the rate of heat transfer decreases. "You're insulating with ice," explains Eugene Hise, senior engineering analyst at Oak Ridge. There, in a large basement-like laboratory, I saw a new piece of hardware that may solve that problem: a plate ice maker.

You may not know exactly what a plate ice maker is, but you've probably used one. "What's the first thing you do when you check into a motel?" Hise asked me. "You probably run down the hall and shovel out some ice from the ice machine, right? Well, concealed inside that box is a plate-type ice maker." Water is pumped over the plates, which have a refrigerant circulating inside. When enough ice is built up, a defrost cycle makes the ice fall off into the bin.

"But their method of defrosting is a thermodynamic loser from our standpoint," says Hise. "What they want is nice dry ice; what we want is to deliver heat to the house with a minimum of electrical input." So the Oak Ridge team designed a plate ice maker that would do that. As well as eliminating the losses due to ice buildup, a plate ice mak-

Continued

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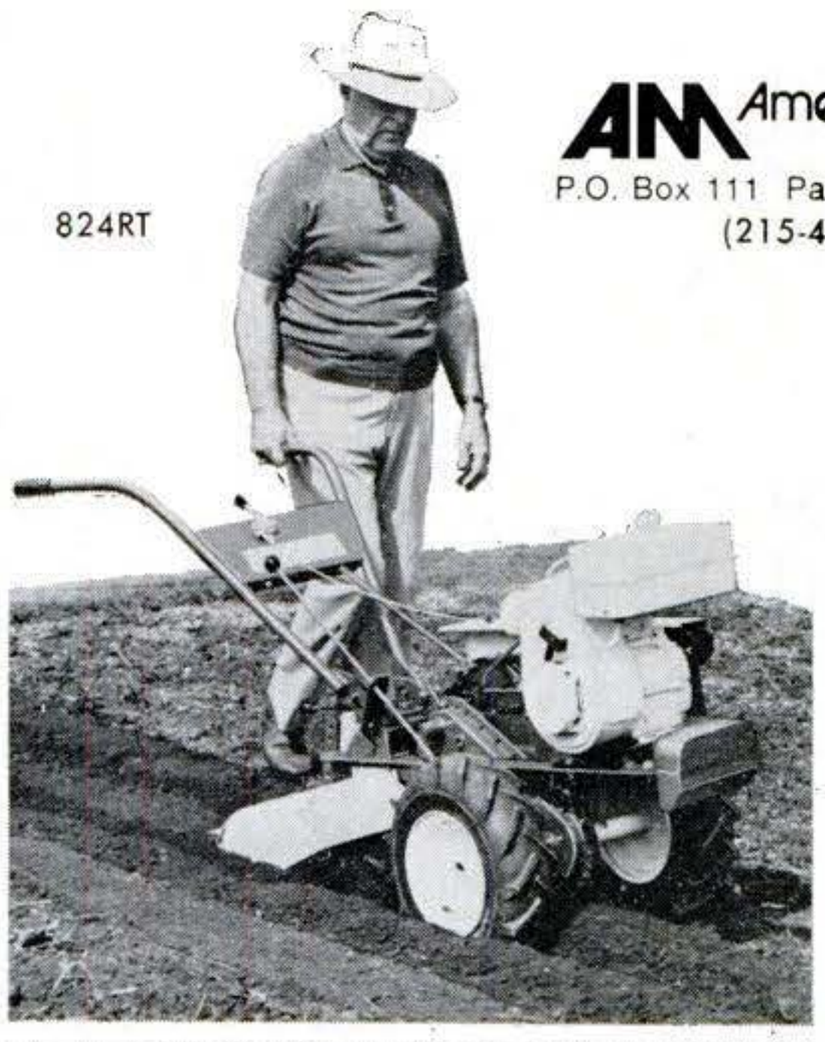

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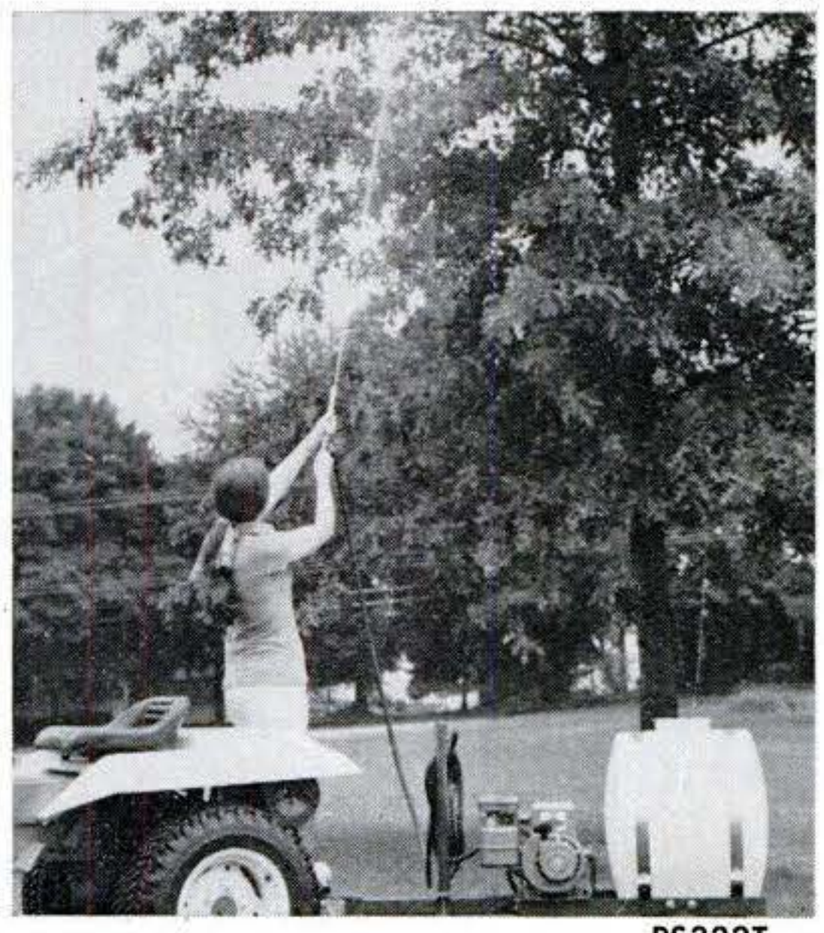

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12-P

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[*Continued*]

er also simplifies the ACES system and makes its installation easier and cheaper.

Knoxville demonstration

A 2000-square-foot ACES demonstration house sponsored by ERDA and HUD has been built just outside Knoxville on property owned by the University of Tennessee. About 50 feet away is a similar-size solar-heated house. Both will be fully instrumented.

The ACES house is a two-story structure with gray vertical siding and nearly windowless walls (only 11-percent fenestration). A 250-square-foot solar collector/radiator panel stands between the two different roof levels. In the basement is the water tank: 2500 cubic feet with 2500 linear feet of coils in it (no plate ice maker for this ACES).

The calculated energy savings for the house are impressive. If it had electric-resistance heating, electric air conditioning, and an electric water heater, the electrical load would be about 14,000 kwh. With a conventional air-to-air heat pump it would be about 11,000 kwh; with an ACES it drops down to 6000 kwh.

"But that's without the 'economy cycle,'" Moyers explains. "There are a lot of hours when the outdoor temperature is low enough for comfort, but you still need air conditioning to keep the inside cool. So we've installed a forced-ventilation system. We can switch over to ventilation cooling when conditions are right." With this so-called economy cycle, another 1000 kwh will be saved.

ACES—a winner?

Whether this or any alternate-energy system will ever gain much popularity depends on many things—mostly economic. "If utilities begin to give lower rates for off-peak electricity use, it'll be a tremendous boon to ACES," says Moyers, "because we have the load-management capability."

An ACES promises to be cheaper to install than a solar system. But like solar heat, it's unfamiliar and pretty bulky. Some builders, however, are interested enough to give it a try. A privately funded ACES house is being built by Ellis Homes in the Richmond, Va., area. And a builder in Des Moines has expressed interest.

Another project, started last summer, is a 60-bed Veterans Administration hospital in Wilmington, Del. Large commercial buildings may indeed be the best market for ACES. That's partly because of the inherent economies in larger systems. Also, large commercial builders are more familiar with life-cycle costing, and aren't as likely to blanch at the higher initial cost.

If the enthusiasm of the people involved in a project is any forecast of its eventual success, then ACES will surely be a winner. I heard about some problems as I talked to the ACES teams: Water tanks leaked; insulation got wet; a pump broke down. But mostly I heard comments like Tony Venturino's: "Of all the things I've seen to date—like wind energy or solar panels—I'd say that if anything has a real possibility to save energy, this is it." PS

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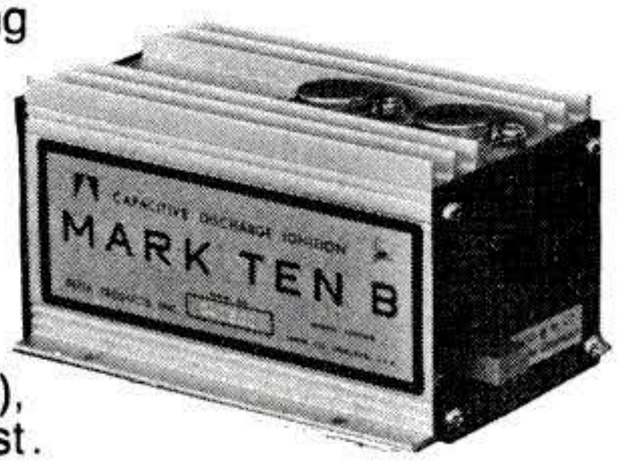

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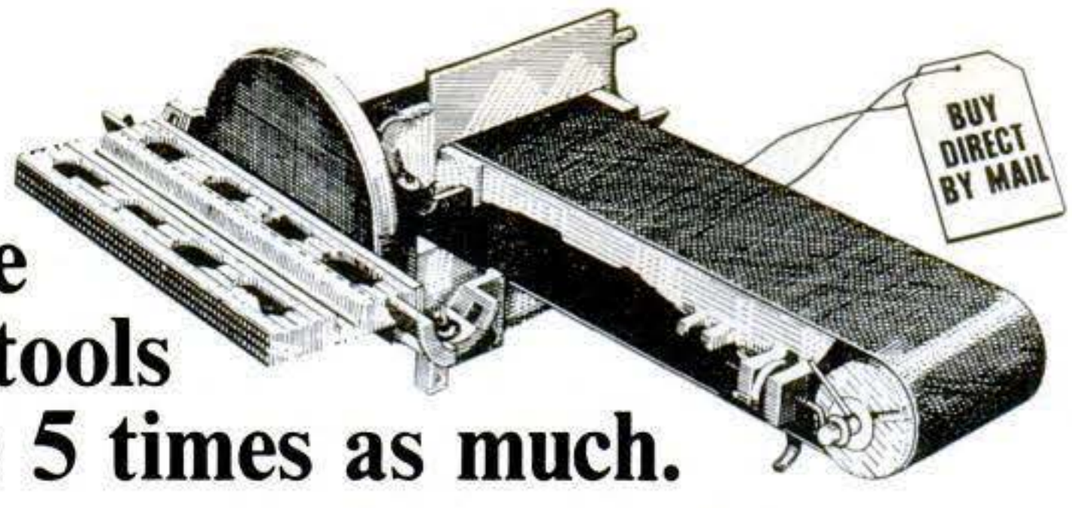

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Two new workbenches

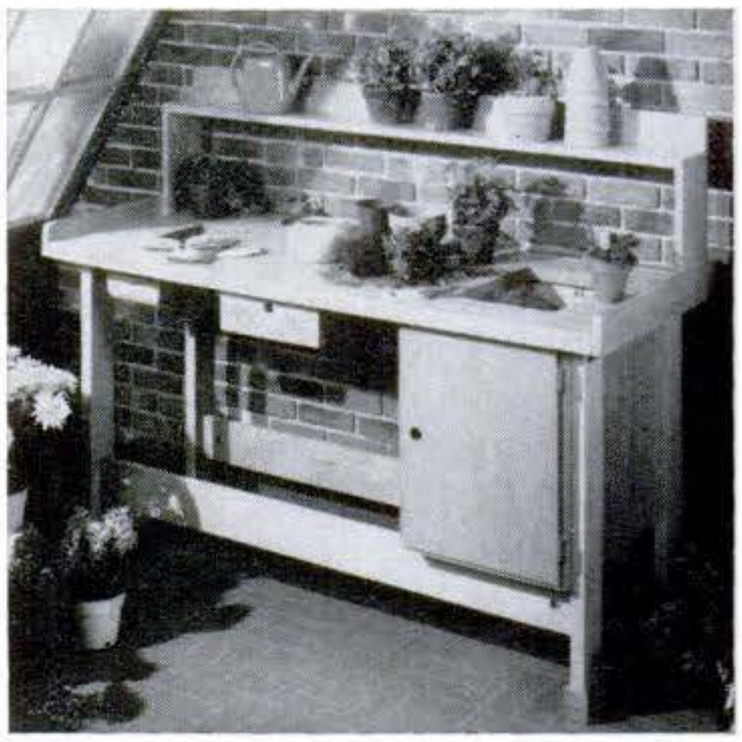
One for your greenhouse; one for your shop

Good-looking enough to grace your family or rec room, these new American-made Craftool benches offer European-style craftsmanship in high-quality hard maple.

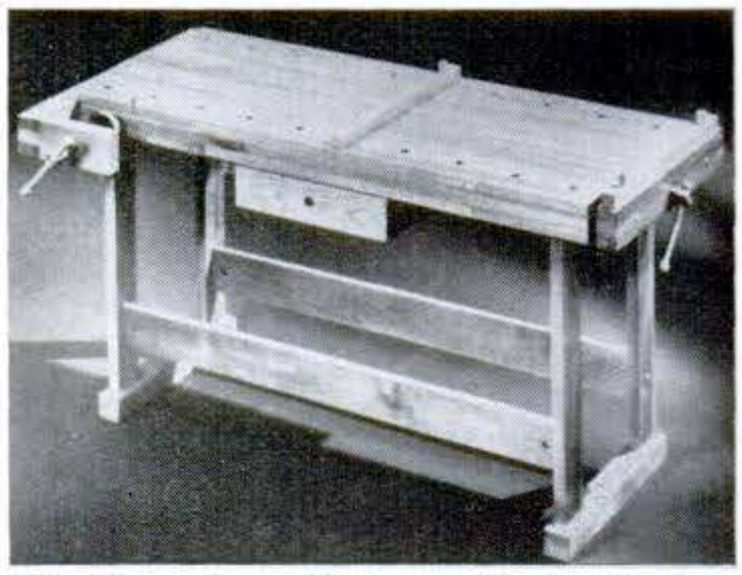
Dovetail construction gives the workbench added strength; its finish is a high-grade furniture lacquer. A 24-in. clamping vise can be used with movable clamping bars held by adjustable hardwood dogs. Other features: a 24-in. bench vise that opens to 12 inches, and hand-carver's vise with a 6-by-9-in. jaw.

The potting bench has two built-in soil bins, a t-&-g-constructed drawer, and a surface-level waste bin. The cabinet locks for safe storage of chemicals and tools.

The workbench is $250, potting bench, $299. Shop-Vac (2323 Reach Rd., Williamsport, Pa. 17701) is the maker.—*Susan Bronson*



Potting bench is 33 inches high, 25 in. wide, 62 in. long. Raised shelf for storing or hanging pots and tools allows clutter-free work surface.



Workbench can be assembled and taken apart in a few minutes for storing or moving, says the maker. Its dimensions: 33 inches high, 24 in. wide, 62 in. long.

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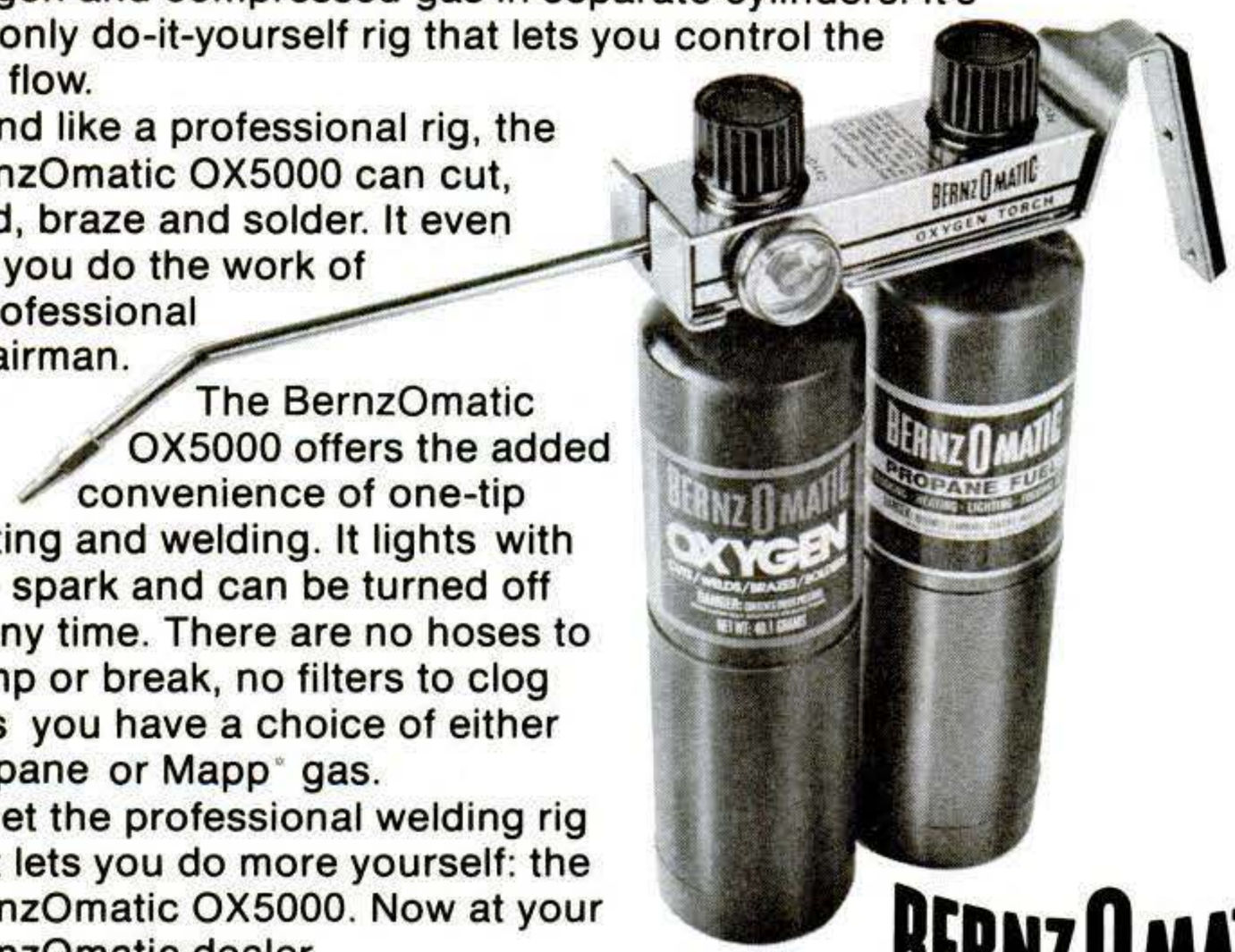

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A secret revealed: X system

When Franklin Roosevelt had something earth-shaking to say to Douglas MacArthur or Winston Churchill, he didn't use your ordinary telephone. Instead, he used the X System, which, developed in the 1940's by Bell Laboratories at the Signal Corps' request, has been a U.S. government secret for 33 years.

Only recently has the system been declassified and patents (30) applied for. Two major patents have been granted to Robert C. Mathes and Ralph K. Potter, former Bell engineers who helped design the first speech-encoding secrecy technique to make speech decipherable only by the intended receiver.

Directed into a specially designed handset, Roosevelt's voice produced electrical signals that were combined with electronic pulses called key signals. Speech and signals were transmitted by shortwave radio. At the receiving terminals—Australia or the Philippines, for example—the key signals were algebraically subtracted by a series of electromechanical relays and MacArthur would hear nothing but his commander's voice.

The nature of the key signals was changed frequently—that's what made the X System secret, and different from previous privacy systems—and recorded on discs containing enough information to encode and decode 30 minutes of speech. Transmitter and receiver simultaneously started their records, which were replaced daily. Fifty times a second, each of 10 frequency bands of the speaker's voice was sampled and assigned a different signal-amplification value. Our present telephony uses the same principle in its pulse-code modulation, which, however, samples the speech-produced electric currents more frequently—thousands of times a second.

The solid-state systems that simplify present telephone circuitry [PS, Sept.] didn't exist in the '40's, and so the X System required more than 30 seven-foot racks fitted with vocoders (the encoding/decoding speech-transmission device invented in 1936), oscillators, phonographs, filters, and about 1000 vacuum tubes. Also required: 30,000 watts—and an air-conditioned environment.
—*Bryan H. Berry*

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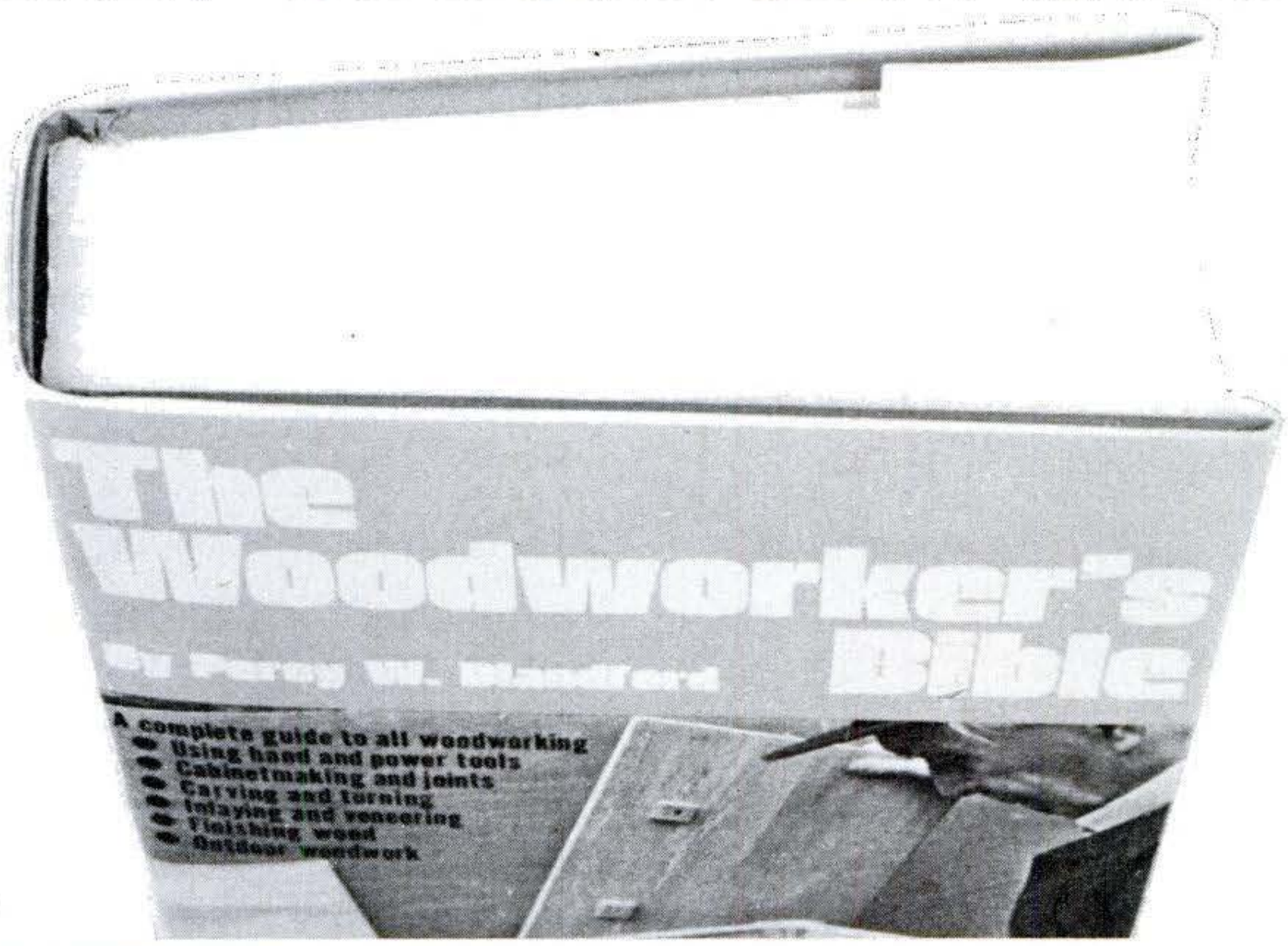

The Woodworker's Bible

This brand new and complete 420-page guide to ALL woodworking includes using hand and power tools, cabinetmaking and joints, carving and turning, inlaying and veneering, finishing wood, and outdoor woodwork. If it can be made from wood, you'll learn how to go about doing it from master craftsman Blandford who, in this encyclopedic new volume, covers every aspect of working with wood. No description can adequatey describe what lies between its covers, for it contains more useful information, more hard facts, more practical hands-on data about woodworking than can be imagined. It's more than a mere how-to book...it's an encyclopedia of "how-to-do-it" techniques that makes it possible for even beginners to duplicate almost any wooden article. You learn what hardwoods and softwoods are and, in a huge 54-page Chapter, all the know-how you need to gain a complete mastery of hand tools. Power tools are next: what features to look for, and the drawbacks to be aware of when purchasing drills, planers, saws, sanders, lathes, etc.—plus scores of helpful hints on how to get the most out of your equipment.

Joint-making is the nitty-gritty of cabinetmaking. In these pages, an expert unveils for you the mysteries of all types of joints, including edge and lapped joints, scarfed, expanding and hinged joints, housed-and-mitered dovetails, dadoes, and doweled mortise-and-tenon joints...techniques that can make your creations the marvel of your friends. The subject of turning wood is made so fascinating that the woodworker might be tempted to take up this area of specialization to the exclusion of all others. Beginning with the anatomy of the lathe and a sample project, you're shown all the techniques necessary in turning anything—from bowls to bedposts—including making complete spheres, laminated designs, and articles like boxes and lids fashioned from a single piece of wood. If it can be carved in any way, Blandford has the method for it, from simple whittling to paring chains and balls in cages from a single piece of wood, not to mention that old mystery, a ship in a bottle. He also shows how to embellish articles already made, using chip carving, incised carving, edge decorating, and relief carving. Also discussed are carving and turning in combination, carving figures in relief, wood sculpture, linen-fold designs, carving twists into furniture legs, and entirely three-dimensional carving. These techniques can also be used to duplicate or repair antique furniture. A Chapter on veneer, marquetry, and inlaying introduces yet another aspect of the craft that can be wholly absorbing in itself. Once again, techniques are presented that can be used to enhance previous work, like inlaying a checkerboard into a tabletop. Other methods can stand by themselves, such as marquetry, in which complete and attractive pictures are built up from inlaid veneers. Also comprehensively covered are picture framing and finishing wood. A Chapter on outdoor woodwork includes fences and gates, plus complete instruction on rustic woodwork and how to lay redwood decking. For your home's interior, there are suggestions on making use of wasted space: built-in furnishings, shelves, seats that fold away, and making use of a neglected alcove. Also included are hints on building doors and putting up paneling, and detailed data on laying out and constructing stairs and steps. All in all The Woodworker's Bible represents one of the most comprehensive coverages of the subject available in a single volume. 420 pps., 1151 illus. Hardbound. Publisher's List Price $10.95

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By ROY DOTY

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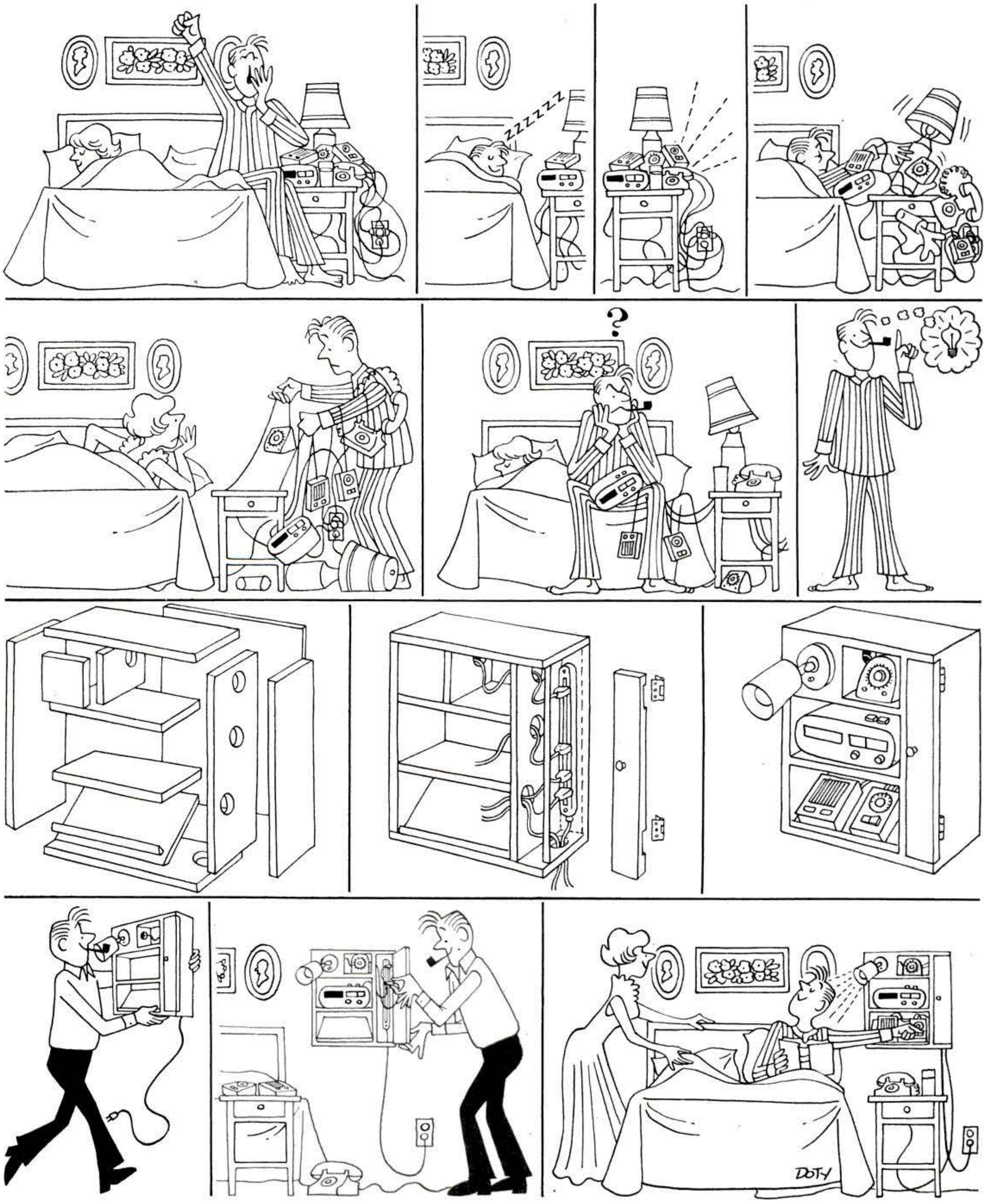

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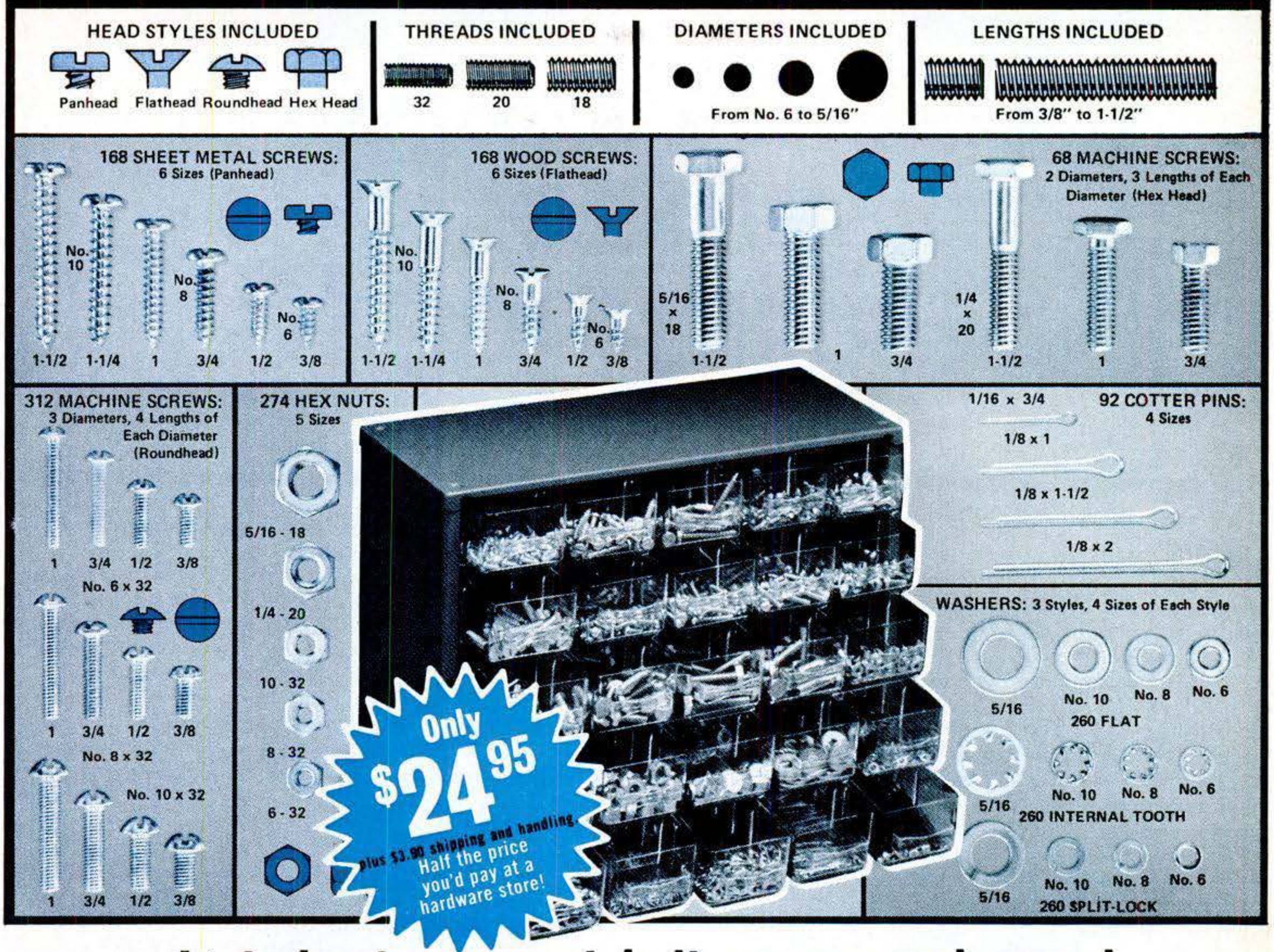

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Inspecting and servicing wheel bearings

By ART HUGHES

If your car is a 1970-1977 domestically built model, its wheel bearings should be serviced every 24,000 to 30,000 miles; in older models, every 15,000 to 20,000 miles.

Bearings that don't get the service they need will make noise (usually grinding) or cause front-wheel shimmy and loose steering. In advanced stages of neglect, the bearings can get red hot and cut through the wheel spindle (axle), or disintegrate entirely. When they fail, the wheel can come off.

In most cars, service is confined to front-wheel bearings, because rear-wheel bearings in cars with rear differentials are lubricated by "splash" from rear-end gears.

On front-wheel-drive cars, rear-wheel bearings usually require the kind of service discussed here. Consult your shop manual for particulars. The servicing procedure outlined here can be used for every make of U.S.-built car and most foreign models having a rear differential.

1 Raise the car and check the rear wheels—just as you would to change a flat tire. Place a jack stand under the A-frame so the car can't fall. If you don't know where the A-frame is, or where to place the jack stand, a mechanic can show you in a few seconds.

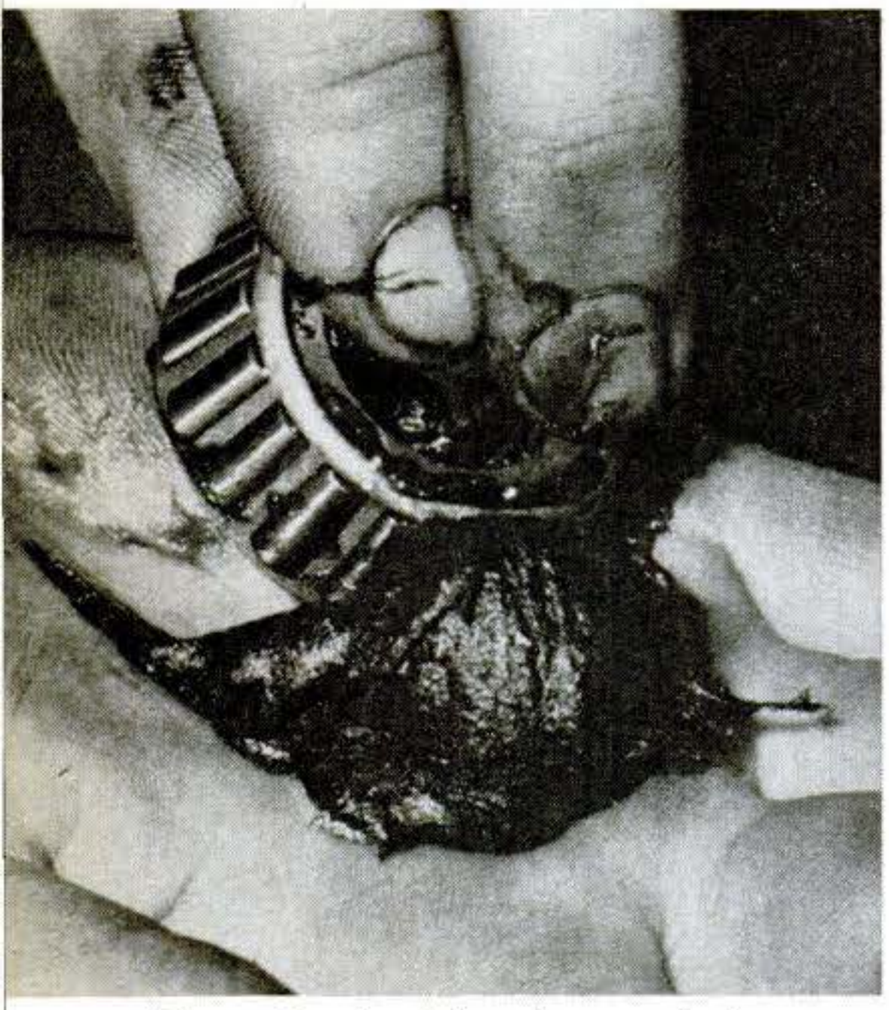
2 If the wheel has disk brakes, proceed as follows:

(a) Remove the hub cap and wheel. This exposes the brake disk and caliper.

(b) Unscrew the fastener or fasteners that hold the brake caliper to the disk. Fasteners may be bolts or a lock-clamp assembly. Carefully tilt the caliper off the disk.

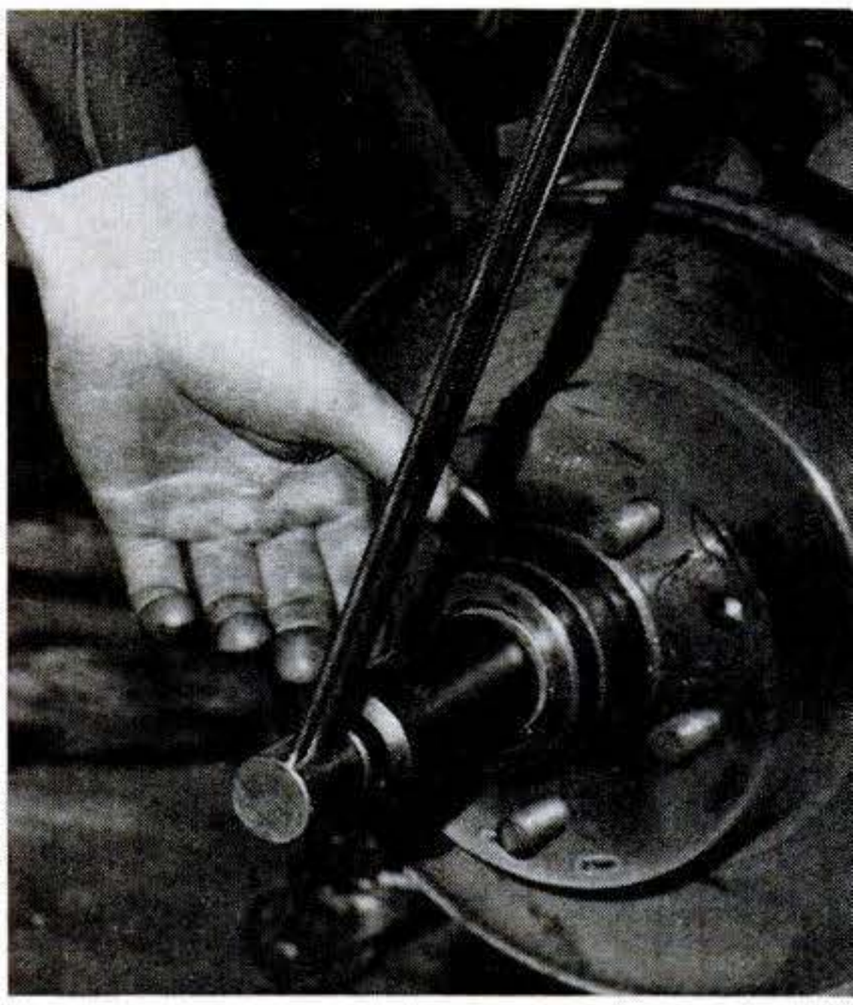
(c) Cut off the straight section of a wire coat hanger and make a hook at both ends. Hook one end to the caliper and the other end to the chassis. The caliper should not be allowed to hang from the brake hose.

(d) Pry off the bearing dust cap with a screwdriver. Straighten the legs of the cotter pin, which keep the castellated locknut and adjusting nut in place, and remove and discard the cotter pin. Take off the locknut, the adjusting nut, and the washer.



To pack wheel bearings, grip by races and repeatedly press down through grease, rotating unit to grease all rollers.

Use a brass drift when removing and replacing bearing cups. The brass is soft and will not harm the steel cups.



A torque wrench can be used to retighten wheel bearings (check manual for ft./lb.). Standard wrench will also do.

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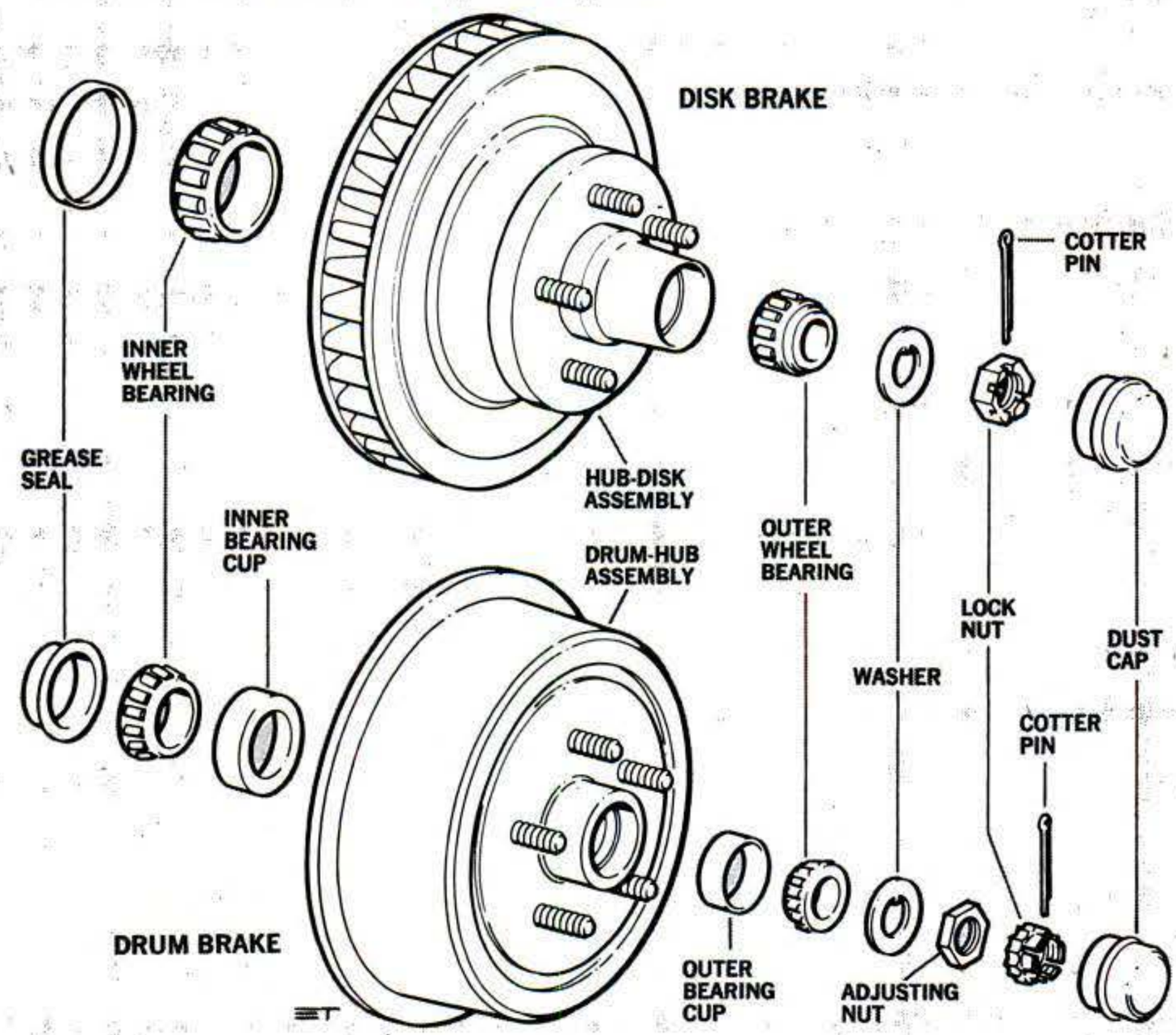
How disk and drum setups compare



(e) To remove the outer wheel bearing, you may have to shimmy the disk a bit from side to side, pulling it toward you a short distance without taking it off the spindle. Then, push the disk back with a jerk. This will cause the outer wheel bearing to fall onto the spindle. Many times, though, you can just pluck the outer wheel bearing from the hub by hand. Put the bearing—and all the other parts you've removed so far—into a clean container of kerosene. When you remove the inner wheel bearing, place it in a separate container of kerosene. This prevents accidentally installing outer and inner wheel bearings in reverse position.

Usually, there's enough difference in size between the inner and outer wheel bearings (the inner bearing is bigger) that it's impossible to install them incorrectly. But keep them separated so there's no chance that you'll try to install the bearings on the wrong side.

Don't let bearings lie on the bottom of the container. Dirt settling to the bottom can get between rollers. Instead, loosely loop one end of a piece of wire around the bearing and hook the other end over the rim of the container.

Important: Before handling a bearing wash and dry your hands. Do not grasp a bearing by its rollers: Handle it by its edges (races). Grit and moisture transferred to rollers may cause damage.

(f) Keep the brake rotor on the spindle and screw the adjusting nut back on the spindle. Draw the disk forward until you feel the adjusting nut contact the inner wheel bearing.

Push the disk back about ½ inch and then jerk it toward you. The adjusting nut will force the inner wheel bearing and grease seal from position. They will fall free on the spindle, and the disk will come off the spindle.

(g) Remove the adjusting nut. Take the inner wheel bearing off the spindle and put it in kerosene. Discard the grease seal.

3 If your car is equipped with drum brakes only, the tire and wheel do not have to come off, but are kept attached to the brake drum. We refer to this tire-wheel brake-drum assembly as the "wheel assembly." The procedure for removing front wheel bearings is as follows:

(a) Remove the hub cap and pry off the bearing dust cap. Remove and discard the cotter pin, and take off the castellated locknut and adjusting nut and washer.

(b) Pop the outer wheel bearing from its seat by jerking the wheel assembly toward you and then pushing it back.

(c) Pop the inner wheel bearing and grease seal from place by screwing the adjusting nut back on the spindle and using the nut to push against the bearing as explained before. Remove the adjusting nut, inner wheel bearing and grease seal; discard the seal.

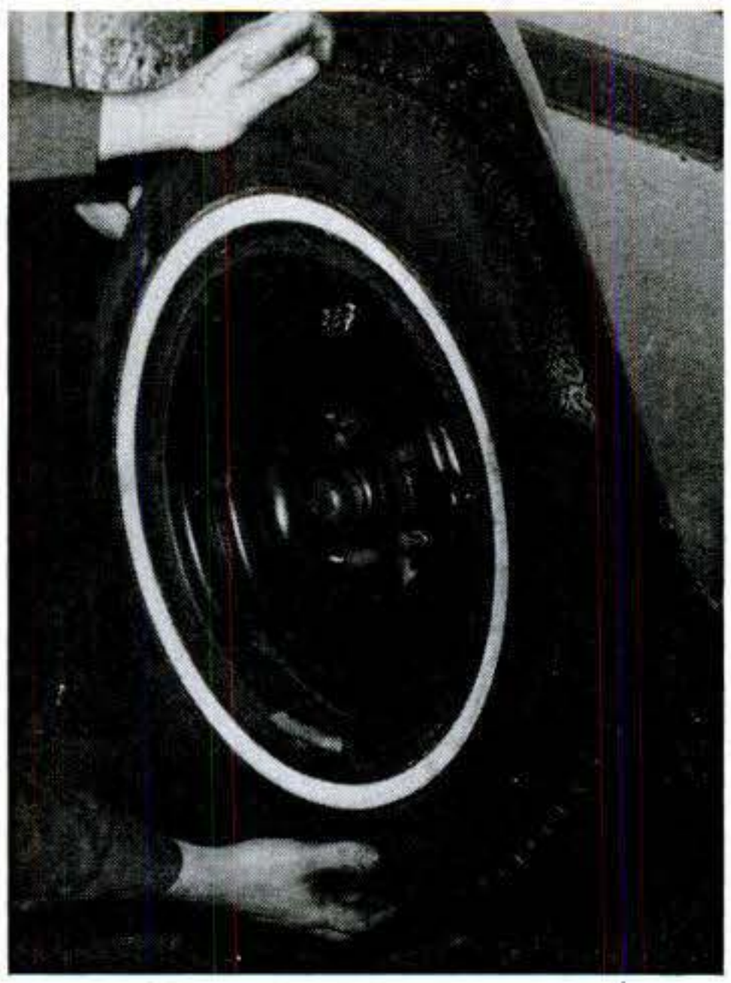
Note: If the inner wheel bearing does not pop loose, take the wheel assembly (or disk) off the spindle, lay it face up on a clean surface, and tap the bearing and grease seal out of the wheel assembly (or disk) with a soft brass drift.

Wash each part thoroughly in kerosene. Use a new paintbrush to work solvent between bearing rollers and then slosh the bearing up and down in the kerosene vigorously enough to flush out all dirt and metal particles.

To clean the inside of the disk-

Continued

Use the wrench to snug up the adjusting nut to seat the bearings, then back off and use fingers for final adjustment.



By pushing wheel back and forth you can check bearing play. Bearings should have only very slight side-to-side play.

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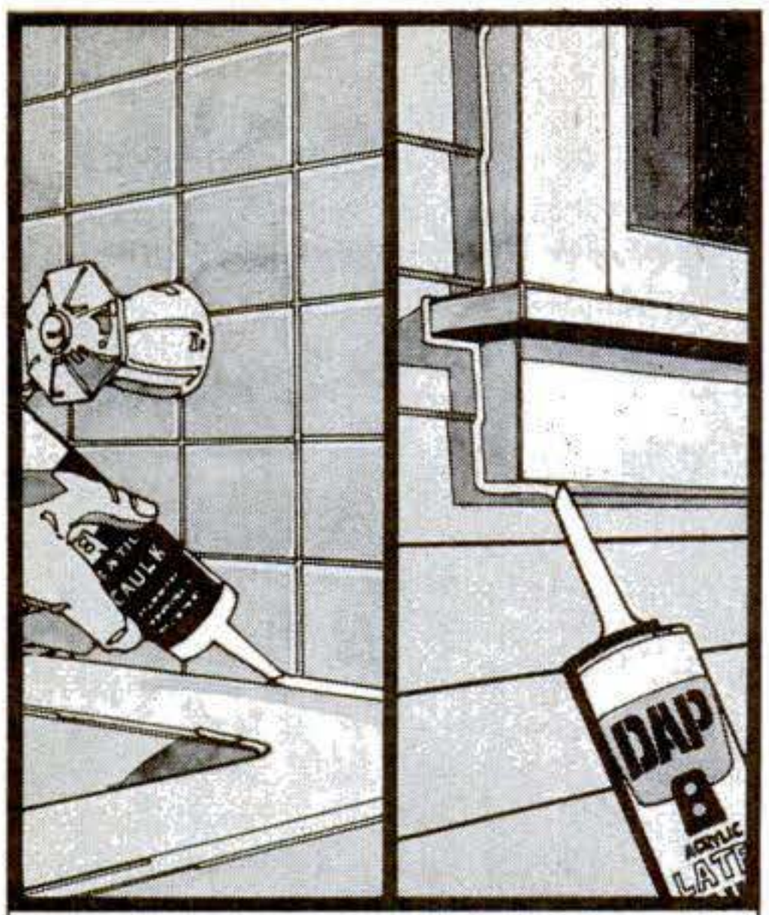

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brake rotor, or the inside of the drum-brake hub, just soak an old rag in kerosene and wipe away all the old grease. When regreasing the bearings, it's not necessary to apply any grease to the inside of the rotor or drum.

Put washed parts on a sheet of clean wrapping paper and let them dry. If compressed air is available, you can hasten drying by playing short bursts of air on parts. Spinning the bearings with air pressure, however, will damage them.

When bearings are dry, inspect each one carefully. If a bearing is cracked, pitted, rusted, or otherwise damaged, get rid of it and its cup. Each bearing has its own cup, which is inside the disk or wheel assembly. To remove the cup, knock it from place with a soft brass drift as shown. To install a new cup, tap it into position in the disk or wheel assembly with the drift. (Brass drifts are available at auto-parts stores and hardware stores. Don't use a steel punch; you may damage the cup. Brass is soft and will not hurt it.)

A bearing that is black has been overheated. Replace it and its cup if you notice this sort of discoloration.

Rotate the bearing slowly and gently, feeling for scratchiness; this indicates that grit has worked between rollers and means that the bearing and cup should be discarded.

After inspecting bearings, shine a flashlight inside the wheel assembly or disk and inspect cups. If a cup is damaged in any way—or scratched, pitted, or rusted—replace it and its bearing.

Greasing the bearings by hand must be done methodically to assure full lubrication. Start with clean hands or slip on a pair of disposable plastic gloves. Scoop up a glob of lithium-base wheel-bearing grease (sold at auto stores), and knead it onto the bearing, making sure you get grease between all the rollers.

Grease the inner wheel bearing first. When it has been lubricated, lay the bearing into its cup in the disk or wheel assembly. Grease the other wheel bearing, and lay it on a clean sheet of wrapping paper.

You now have to install a new grease seal (also available at auto-parts stores). Smear a light film of wheel-bearing grease on both sides of the seal and lay it carefully over the inner wheel bearing. Tap the seal gently into position by placing a block of clean, smooth wood over it. When the edge of the seal is level with the lip of the hub, the seal is properly seated.

Be careful not to damage the seal during installation. If you do, get another. Grease will seep past a damaged seal and get on braking parts, which will cause erratic brake operation.

Put the wheel assembly or disk back on the spindle. Put the outer wheel bearing in place, replace the washer and adjusting nut, and run up the adjusting nut finger-tight.

If you have a disk brake, replace the caliper assembly.

4 Ideally, wheel bearings should be adjusted to shop-manual specifications with a torque wrench. However, if a torque wrench isn't available, you can get by with "feel." Here's how:

(a) As you rotate the wheel forward, rotate the adjusting nut with a wrench until the nut is snug—not tight. The purpose of this initial setting is simply to seat the bearings.

(b) Back off the adjusting nut to the "just loose" position.

(c) Hand-tighten the adjusting nut while rotating the wheel forward.

(d) If you are dealing with a disk-brake setup, back off the adjusting nut at least 1/12 but no more than 1/6 of a turn (that's one half flat of the nut). Insert the castellated locknut and insert a new cotter pin. Bend the legs of the cotter pin back against the nut and cut off any extra length to assure that the ends won't interfere with the bearing dust cap.

Important: In a disk-brake setup, under no circumstances should the adjusting nut be even finger-tight.

(e) With a drum-brake situation, the adjusting nut may be kept finger-tight. Put the castellated locknut back in place and install the cotter pin.

When all parts have been replaced, grasp the tire on top and bottom and attempt to move it back and forth. There should be some perceptible play. Specifications call for end play of 0.001 to no more than 0.005 inch, but you can't measure this infinitesimal amount without a micrometric gauge. The best I can do is tell you that movement should be very slight.

Replace the dust cover by knocking it in place either with a rubber hammer or a steel hammer hit against a block of wood. Hammering directly against the cover with a hard hammer will dent it, so be extra careful here. PS

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[Continued from page 81]

have a true scratch, you can be pretty sure your sample was the real thing—*was*, because the act of testing usually means you've wiped away the sample!"

Diamond-making has now become a standard manufacturing process with little chance of accident. Still, it's the nature of superpressure research that you don't know the limits of new materials or designs until you test them.

So when Bundy modified the belt apparatus to achieve pressures in the megabar range, it was not without risk. Essentially, what he did was to tinker with the piston heads. Instead of using single crystals of pure gem-quality diamonds, he uses a compacted mass of man-made diamonds, the result of a sintering process in which the tiny synthetic crystals are cemented together in a tungsten-carbide base. The random orientations of the many single crystals assure that there will be no major cleavage planes to act as weak spots under stress.

With these piston heads fitted onto tungsten-carbide bodies, Bundy plans to study phase changes in iodine, sulfur, and other elements. He's also interested in finding the triple point of carbon, that magic moment of pressure, temperature, and volume in which carbon's solid, liquid, and metallic phases would be in equilibrium. Some investigators think that if it were possible to recover carbon in the metallic phase, it might turn out to be the hardest material in the world—harder even than diamond.

An advantage of the belt apparatus is that the size of the sample can be relatively large—more than half a millimeter long (about 0.03 inch) and about 2.5mm thick. Its major disadvantages are that it is expensive, and, since the prime mover is a huge press, not exactly back-pocket portable.

Turn of the screw

The NBS diamond-anvil pressure cell, by contrast, is both portable and relatively cheap. It does mean working with samples about a third the size used in the belt, however; but this has other advantages. For one, it explains how you can get super-high pressure without a heavy press. It's simply an application of the principle that pressure is force per unit area. The force applied by a lever-arm against the pressure plate at the base of the metal slab is greatly magnified at the minuscule area of the diamond interface. (Remember when women's spike heels made dents in parquet floors?) All it takes to generate the lever-arm force is the turn of a screw; this compresses a set of spring washers, which exerts a measured load on the lever. Smallness has another advantage in studying explosive materials, such as lead azides. The smaller the sample, the less chance there is of accident.

When the diamond cell was first developed at the National Bureau of Standards in 1959, there was no simple and reliable way to measure the pressures obtained. There were likely to be pressure gradients across the interface, depending on how well the pistons were aligned, how smooth their surfaces were, or on the presence of shear forces, which caused pressure leaks out toward the edge of the field.

Fluorescent ruby

In 1972, an ingenious proposal made at the NBS cafeteria removed this stumbling block. Jack Wachtman, chief of the inorganic materials division at NBS, was lunching with Stanley Block, chief of the crystallography section, and Dean Barnett, then on leave from Brigham Young University in Salt Lake City.

"Have you thought of fluorescent spectroscopy?" Wachtman asked. They hadn't, but Block, Barnett, Gasper Piermarini, and Richard Forman went to work. The idea was to add a crystal of ruby or other fluorescing material to the sample and excite it by shining mercury-arc light on it, then watch what happened to the wavelengths of its fluorescent lines on a spectroscope as pressure was increased. Ruby worked like a jewel. Its main fluorescent lines were sharp and showed a continuous shift toward the red end of the spectrum as more pressure was added.

Extrapolations of the ruby fluorescence scale are now used routinely to calibrate extremes of pressure and temperature. The ruby can be introduced in powder form, mixed with a powdered sample, and inserted directly between the diamonds. Or a tiny ruby chip can be added with the sample and both introduced into a small fluid-filled hole in a metal gasket placed between the diamonds—the way I saw it done in the zinc-sulfide experiment. Under those hydrostatic conditions, pres-

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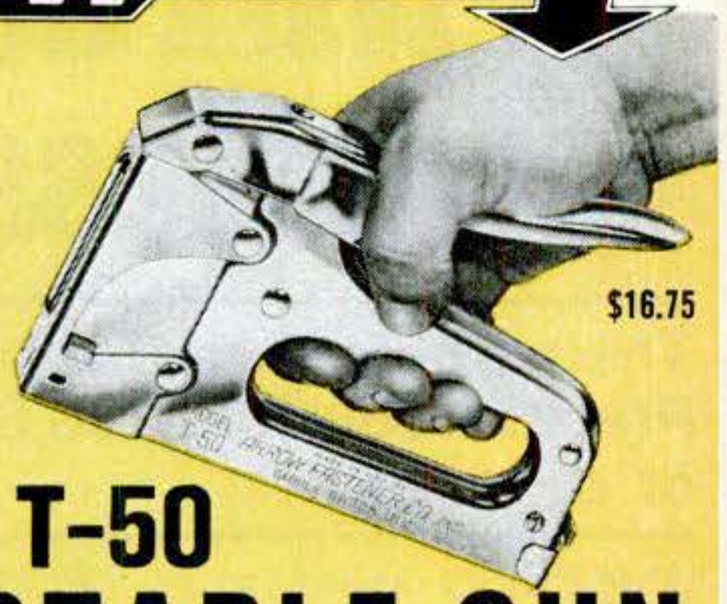

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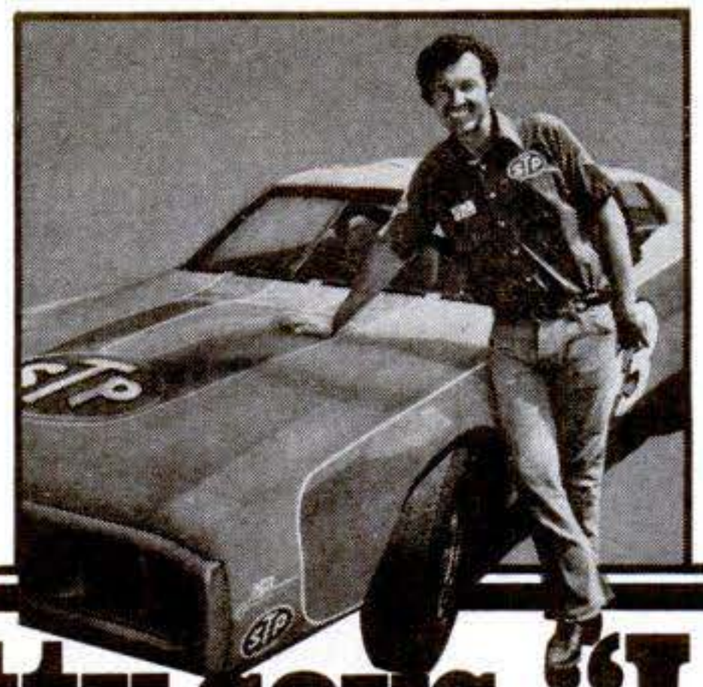

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sure is equalized throughout the field. This allows great precision and accuracy in measurement, a matter of some pride for the NBS, whose primary concern is improving and standardizing measuring techniques used in laboratories throughout the world.

The belt and diamond cell and their variants have become the workhorses in "static" high-pressure research: They can generate megabar pressures, maintain them for long periods, and recover the sample afterward. Using such devices, atomic physicists have studied pressure-induced changes in such phenomena as the rate of radioactive decay of barium and beryllium isotopes.

'Big-bang' pressures

If static high-pressure research sometimes yields an unpleasant dynamic event—the diamond-shattering or press-dropping disaster—it is as nothing compared to what nature can do to generate superpressure. Earthquakes, volcanic eruptions, and other violent spectaculars generate shock waves well in the megabar range. Such seismic events may have been the way natural diamond deposits were brought up closer to the earth's surface after incubating at greater pressure and temperature depths.

Smaller scale explosions, under controlled laboratory conditions, are the dynamic alternative to static methods of achieving superpressure. For a fleeting second such bursts can also generate shock waves of megabar magnitude. They are standard procedures at weapons-testing arsenals and laboratories that use conventional or nuclear devices.

Metallic hydrogen

It was a subtle refinement on a dynamic technique developed by Ronald Hawke and colleagues at Lawrence Livermore Laboratory in California that may have produced the first man-made metallic hydrogen.

The Livermore "magnetic-implosion" method exploits a magnetic field to up the pressure ante. Liquid hydrogen is poured into a copper tube about half an inch across. The tube lies at the center of a larger sleeve of stainless steel, wrapped around with explosives. Air is evacuated from the space between sleeve and core. Just before detonation, a bank of capacitors is discharged to generate a 60,000-gauss magnetic field in the vacuum space. When the charge is set off, the stainless-steel casing implodes. This exerts a steady compressive force on the magnetic flux, building up the field strength to more than 10-million gauss (the equivalent of five or six megabars) to bear down on the hydrogen. The whole process takes about 10 microseconds, three or four times the duration of ordinary shock-wave compression, and with far less generation of heat. (A major disadvantage in shock-wave compression studies is that much of the energy generated gets dissipated in heat.)

X-rays and electrical measurements made at the start and during the hydrogen compression are used to estimate volume and electrical conductivity changes. Since the density estimates, derived from the volume data, are about one gram per cubic centimeter (14 times the density of liquid hydrogen), and the electrical measurements are suggestive of metal, the surmise is that the metallic state of hydrogen has been reached.

A world-wide search

It remains a surmise because the sample, as in most dynamic experiments, is lost in the explosion. What the Livermore experiments hope to establish is the exact transition point for the change of state. With that information, static gear with ever-harder pistons, more massive supports, or powerful presses might then transmute hydrogen and bring it back bright and shiningly alive.

Researchers in several countries are carrying on the search for metallic hydrogen via superpressure. Leonid Vereschagin, head of the Soviet Union's Institute for High Pressure Physics, has built a 10-story-high press that uses a piston head made of carbonade—a naturally occurring, extremely hard form of "black diamond" with which he hopes to bring off the feat. And a Japanese scientist, N. Kawai, at the University of Osaka, has designed a large spherical system that he says has already proven itself to be successful.

In the "show me" world of high-pressure physics, however, most experts remain unconvinced. At the same time, few would deny that this is the way to go. And if metallic hydrogen and other gourmet tidbits from science's newest pressure cookers are not quite ready for the table now . . . wait till next year. PS

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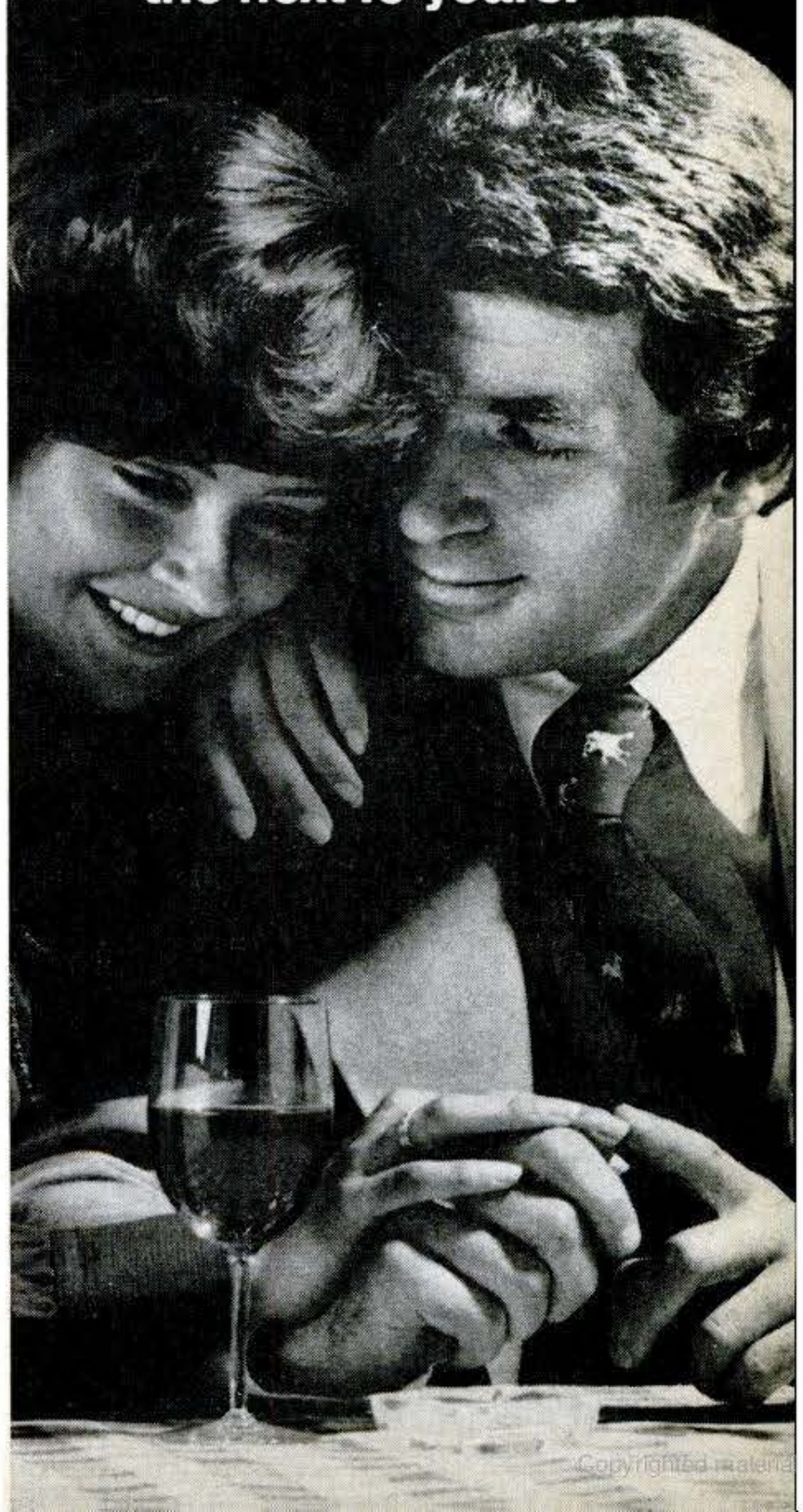

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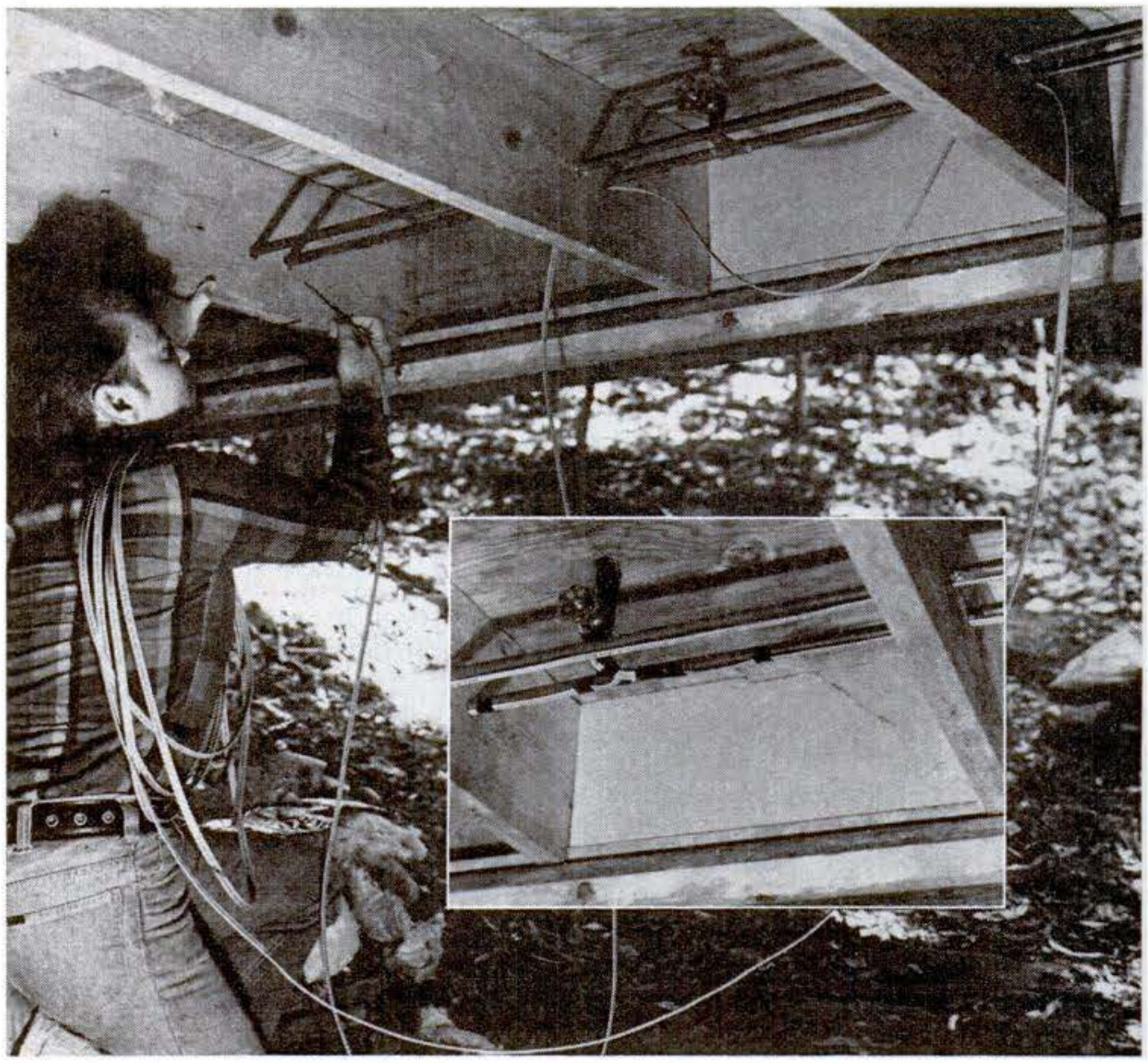
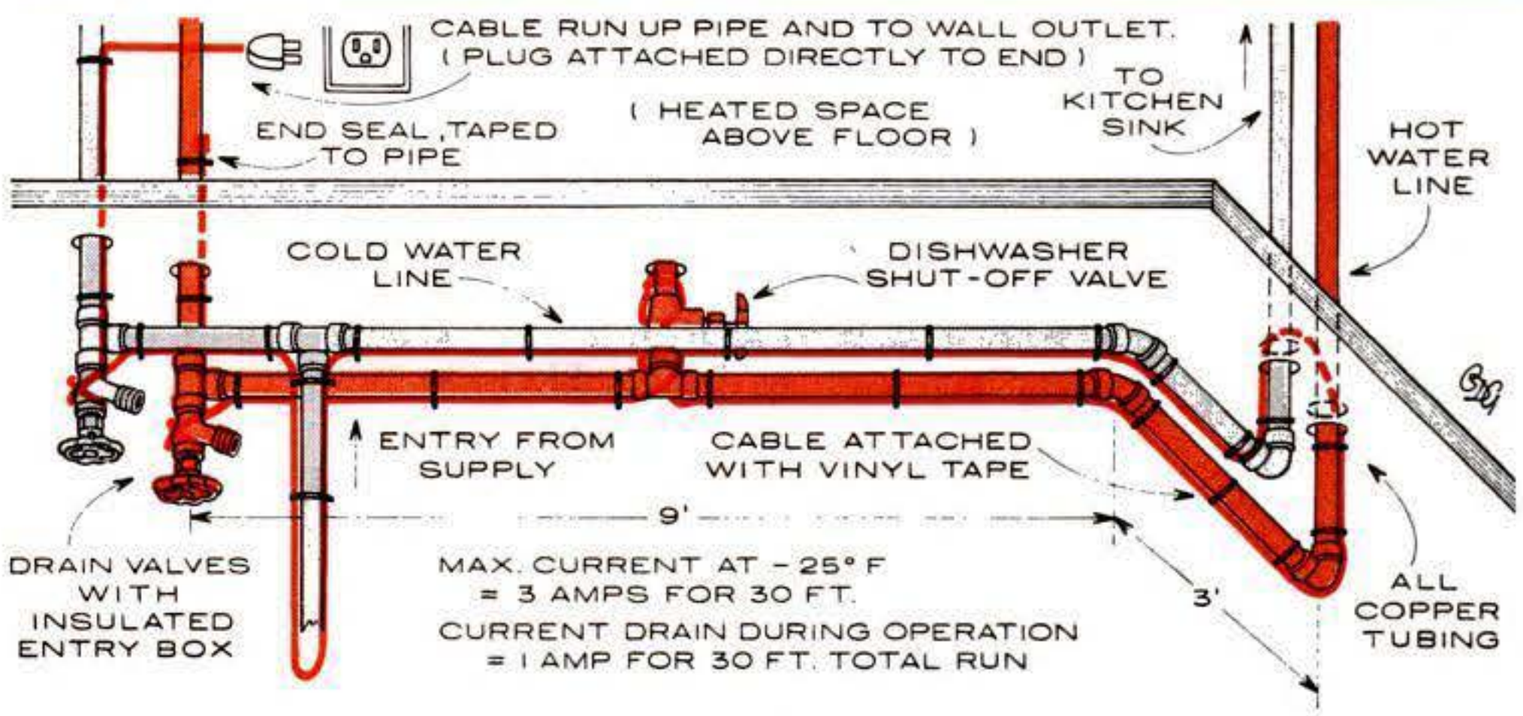
SHOP TALK

By AL LEES





Keep water flowing this winter

PS editors, like other readers of the magazine, often glean something personally useful from reports in these pages. After reading Evan Powell's new-product announcement about a unique heat cable called Frostex [July '76, p. 73], I sent off for 30 feet of it to trace the underfloor waterlines at the Lockbox—the leisure home I built for a series of PS articles in 1972 through 1975. Though the underside of this pole house is insulated and weatherclosed, the runs shown in the photo and sketch froze, last winter, at −20°. Never again.

After dropping weatherboard and fiberglass batts, I found it a simple matter to feed the flat cable through the joist holes, snugging it to the bare pipes every twelve inches with vinyl tape. Wrapping the valves (inset) is especially easy with this cable since—unlike conventional heaters—it can cross itself without damage. Tracing completed, I wrapped the entire run with fiberglass strips, then replaced insulation and weatherboard. For installation tips (and where-to-buy), write Chemelex, 837 Second Ave., Redwood City, Calif. 94063.

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Wiring an "Arkansas" house

In the flood of letters after my September article on new home-insulation standards called for by Arkansas Plan construction, a query from Raymond Tucker of Utica, N.Y., caught my eye: "I was distressed by their policy of running wiring along the sole plate," says Mr. Tucker, an experienced electrician. "This area is vulnerable because, long after the walls are closed up, an unknowing homeowner could drill up through the sole plate from the basement, to get at the stud cavity. Result: electrocution, or fire in the wall."

While it's true that wiring anchored to a sole plate might be more vulnerable to drilling than wiring "floating" higher between the studs, the likelihood of such rewiring is slight; the houses described in my article are all single-story with unusable attics. More importantly, this sole-plate wiring applies only to outside, insulated walls, since it's done to leave stud cavities open for full-thick fiberglass batts. There's no reason not to run wires conventionally through interior partitions, and that's where rewiring would most likely be done. It's bad practice to fish new wiring through *any* insulated wall.

This suggests another tip: When I built my home, I photographed all critical walls after wiring and plumbing runs were in but *before* I closed them. This album of photos is a permanent record to be checked before any stud cavity is probed in the future. It's a good idea for any new construction.

Take a cue from the igloo

This won't come as any news to any Eskimo readers, but snow is an effective insulator. Frost nips much deeper into the earth during a cold-but-snowless winter, and a layer of snow on your roof reduces the chill in your attic and creates a buffer zone between temperature extremes, indoors and out.

If you live in an older house, or in one built on a slab-on-grade, you probably find the ground floors drafty from wintry blasts. The next time you clear any walks and driveways along your house, bank the snow against the foundation. With a lightweight snowblower, you can build a snow 'berm' easily.

If you're snowless, avail yourself of a more conventional draft-plugger—caulking. A good little summary of how and where to caulk, by Macco Adhesives, is titled "10 Money-saving, Fuel-saving Ideas"; ask SCM Corp., Wickliffe, Ohio 44092, to send you a copy.

And if you're shivering right now because you're near a window you've never been able to fit a storm sash to, don't put off an easy afternoon's fix: The DIY aluminum rack at your Home Center should have the special extrusions with glazing channels that let you custom-make a sash for a snug fit. Instructions are clearly sketched in a folder titled "Storm Sash & Screens"; if your dealer can't supply a copy, write Reynolds Metals Co., Building Products Div.—Consumer Products, 6601 W. Broad St., Richmond, Va. 23261. PS

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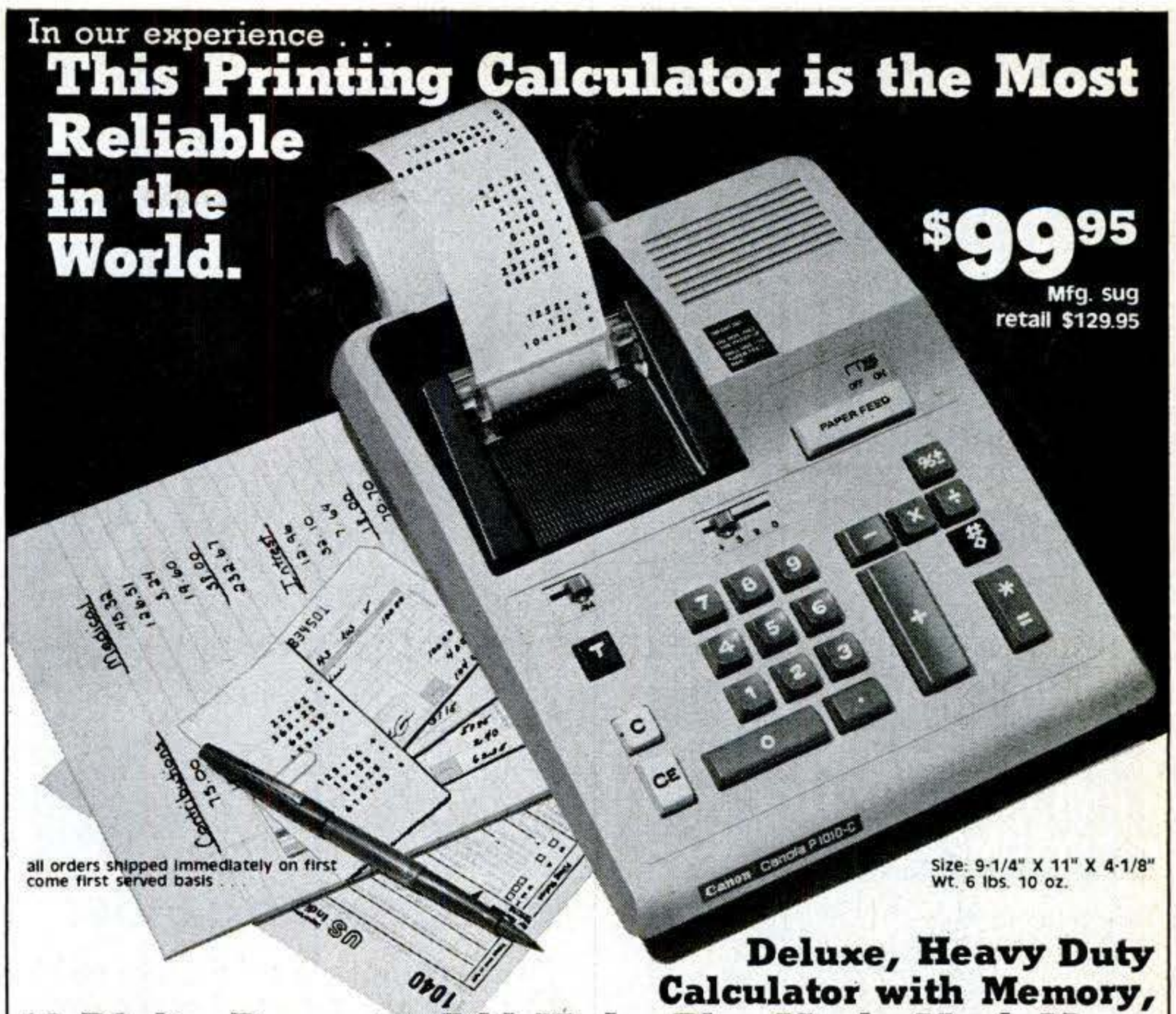

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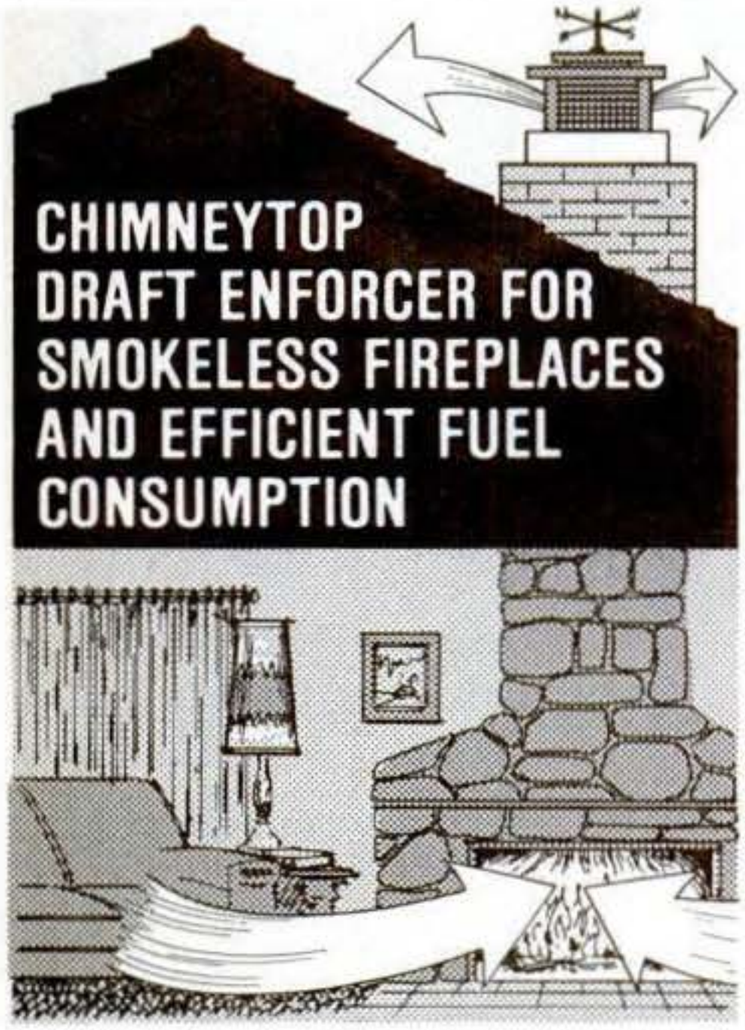

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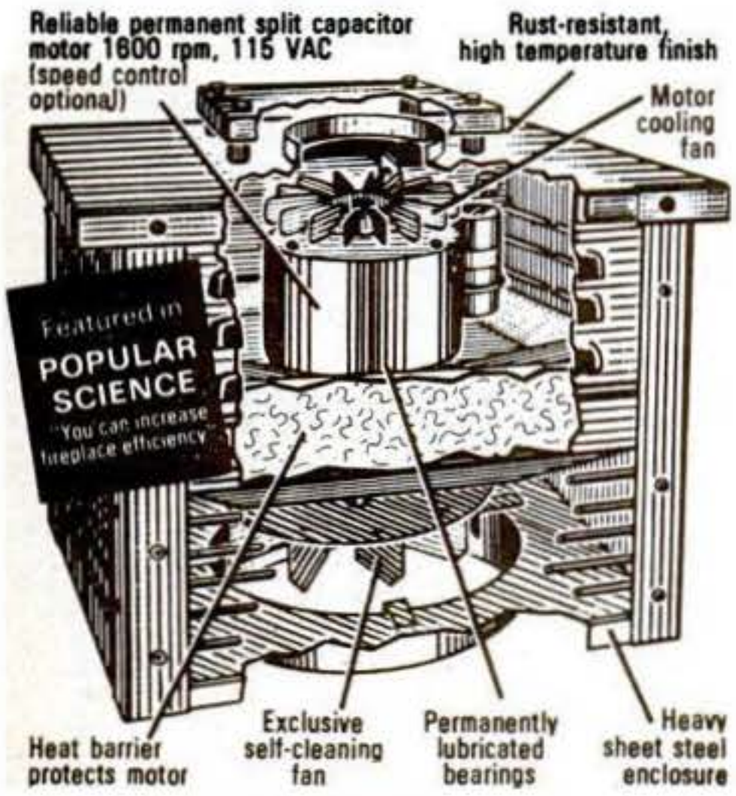

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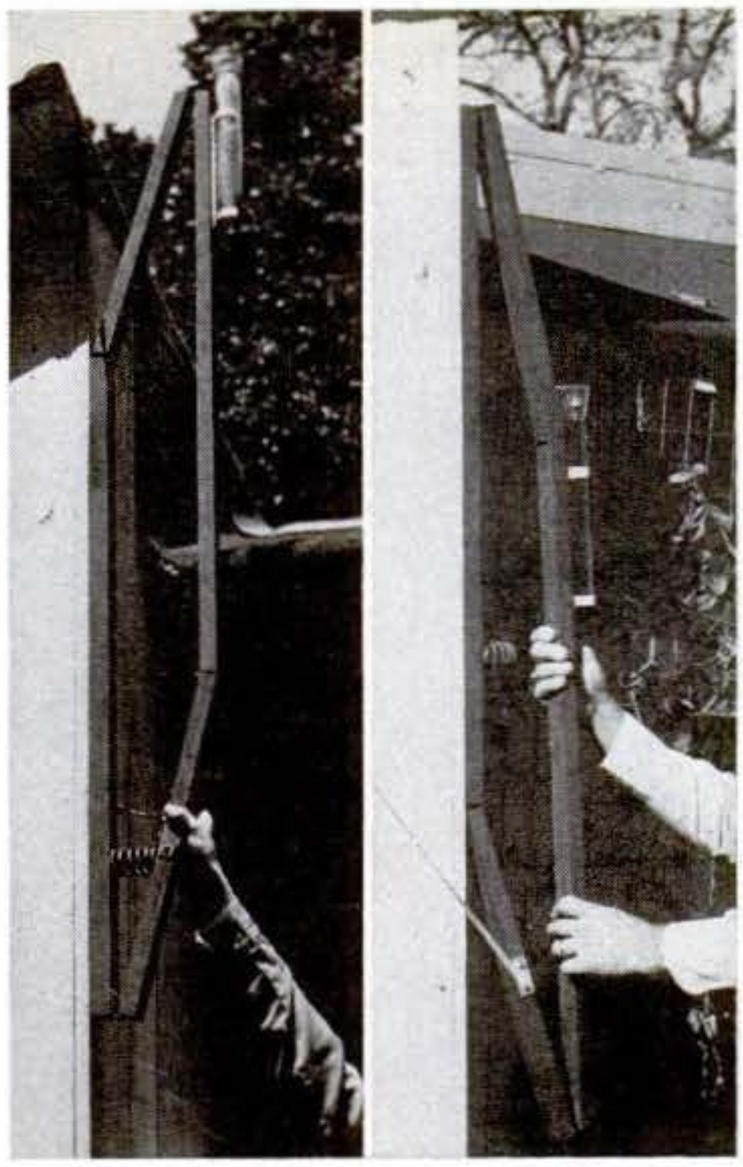

Rain-gauge extender

To be accurate, a rain gauge must be above the roof and away from anything that might cause blowing rain to miss it. But who wants to get a ladder each time a reading must be taken? My little device solves the problem. A screen-door hook holds the gauge up for collecting; unhooked, the gauge drops down to eye level.—*Bob Brown*

Door holder

When you're leaving your workshop, both arms full, this device might save you some trouble. The home-made flip-flopper holds the door open. Then a soft kick sends the door back a few inches to release the holder, which swings down and hangs loose. A spring pulls the door shut, and you're already halfway up the stairs.—*Dan Googins*

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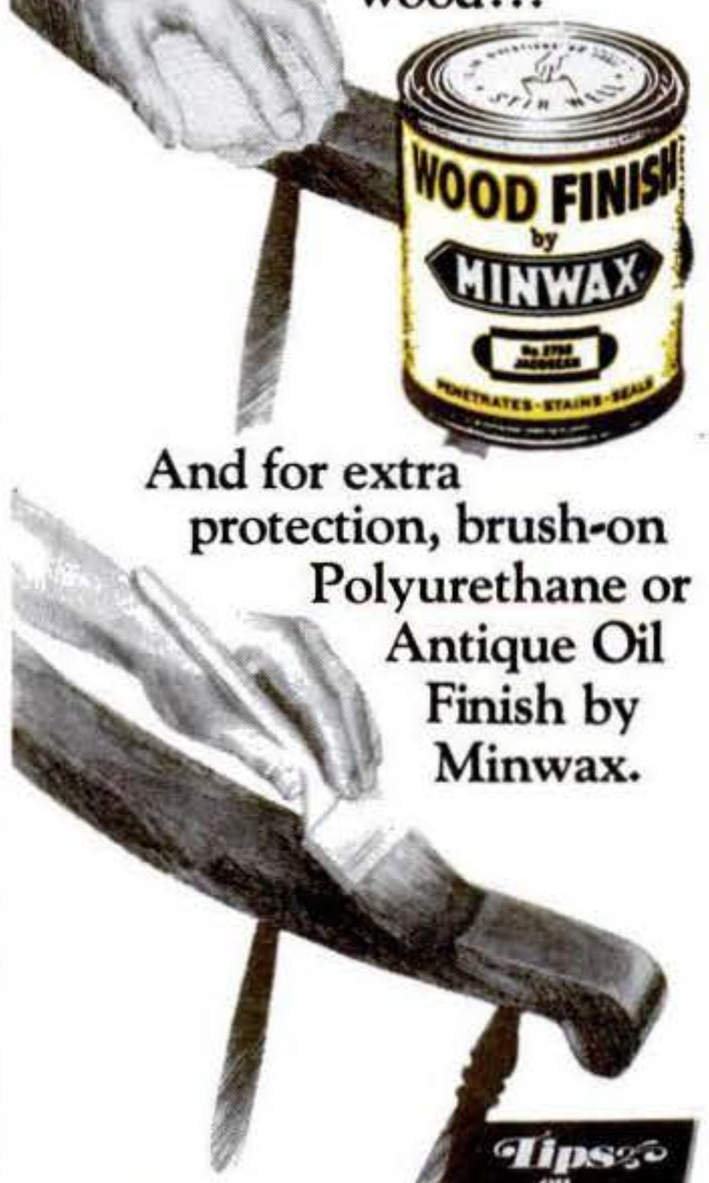

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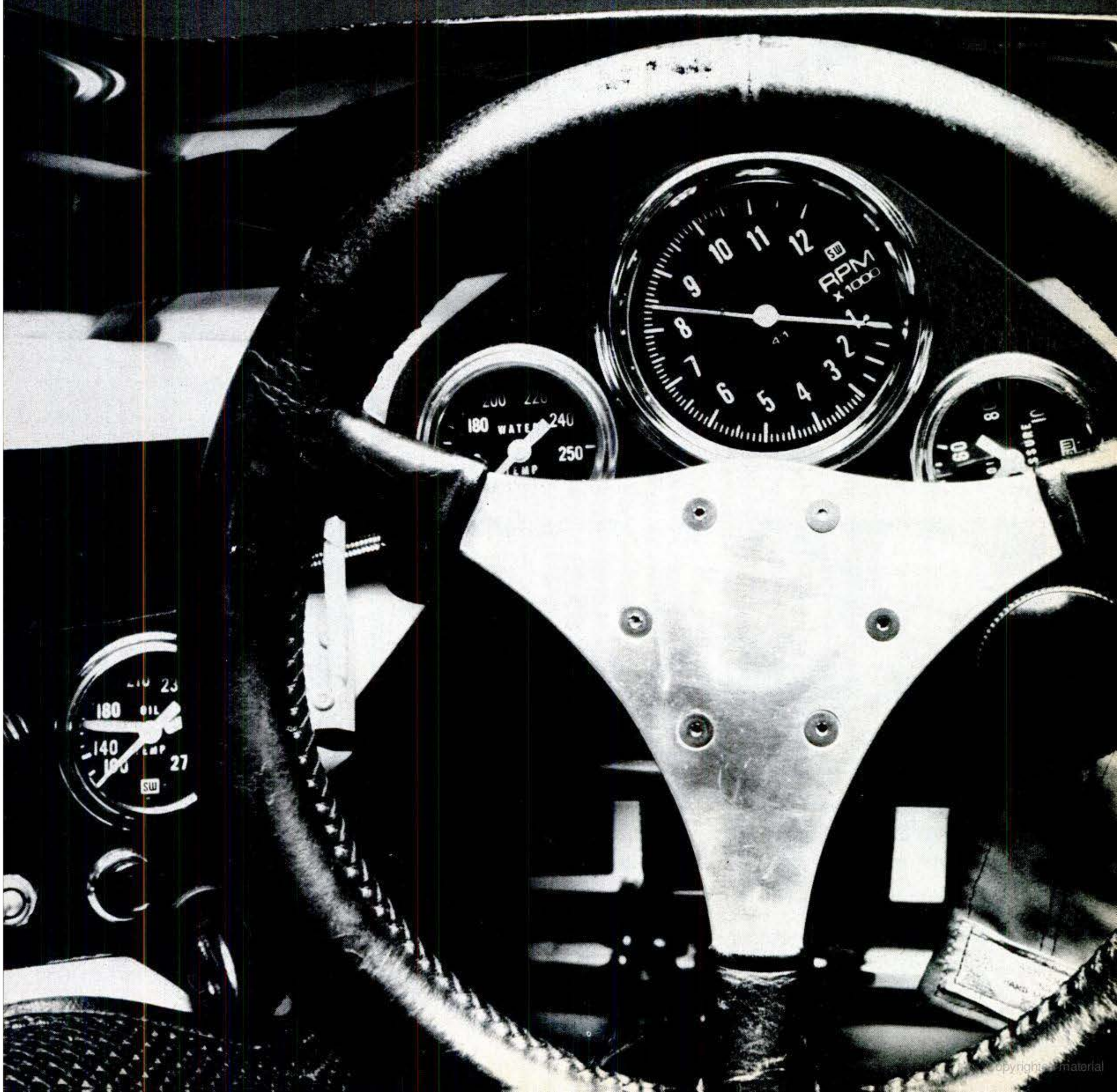

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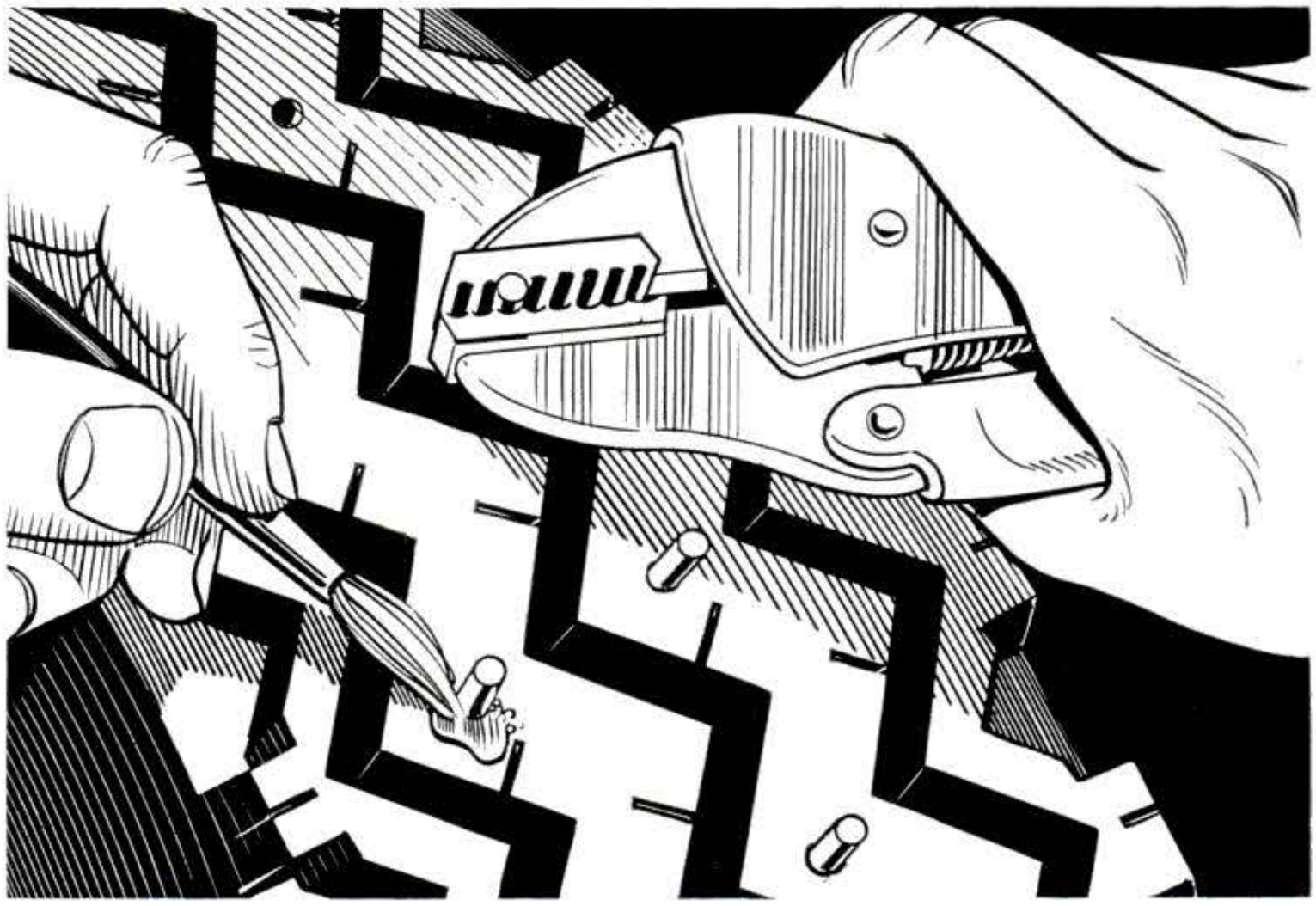
TAKING CARE OF YOUR CAR

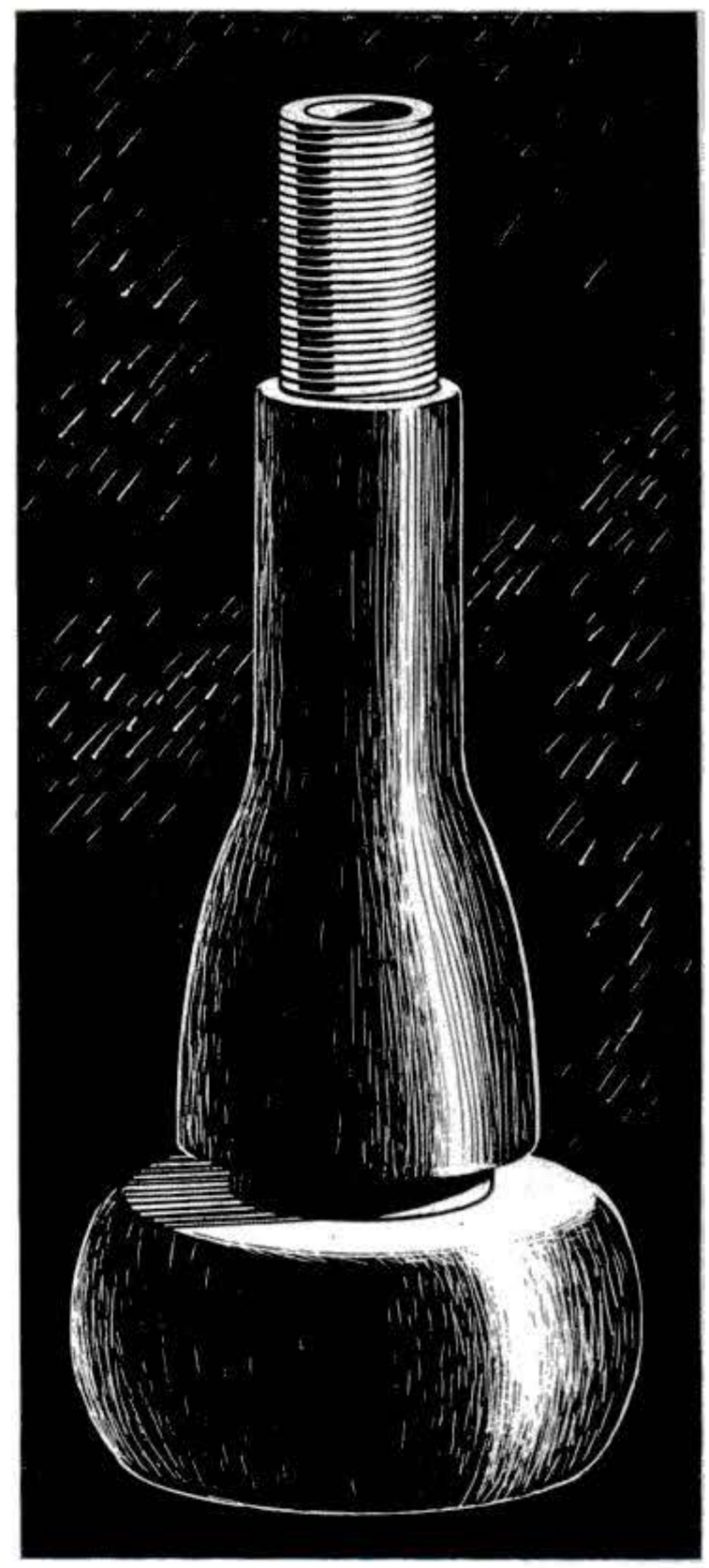
By RAY HILL

Got a useful car tip? Send it (with Social Security No.) to Car Care, Popular Science, 380 Madison Ave., New York, N.Y. 10017. We'll pay you $25 if we use it. If two or more readers send in the same usable tip, the one with the earliest postmark will be chosen. Sorry, but tips can't be returned.



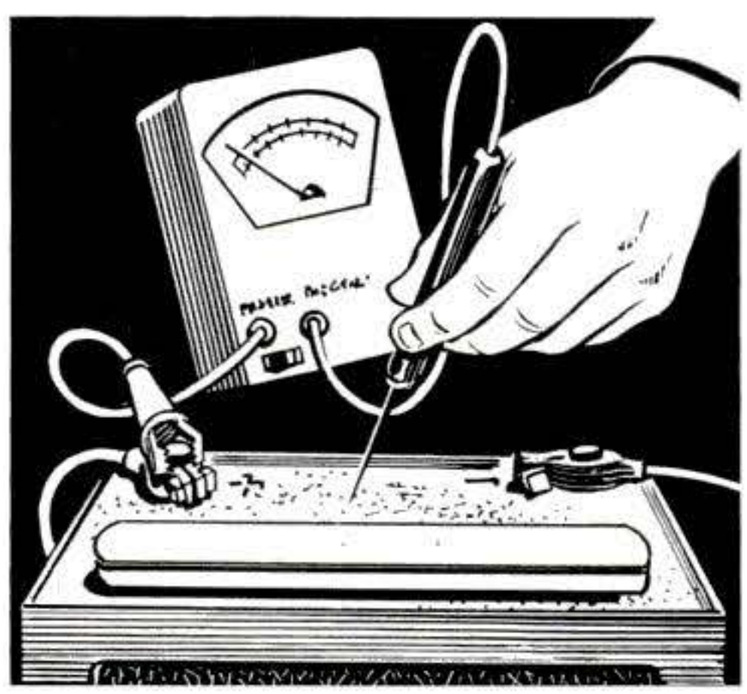
Removing studs from studded snow tires

There's no easy way to remove the studs from your snow tires, which you may want to do because they've been banned in your area. Those 80 or so studs were shot into the tire at the factory, with a hydraulic gun that fired a flanged stud in the hole. The easiest of the uneasy ways, says Goodyear, is to lubricate the rubber around each stud with liquid soap. Then pull the stud out with a pair of locking pliers. Don't use oil as a lubricant—it can damage the rubber. The liquid soap should work fine.



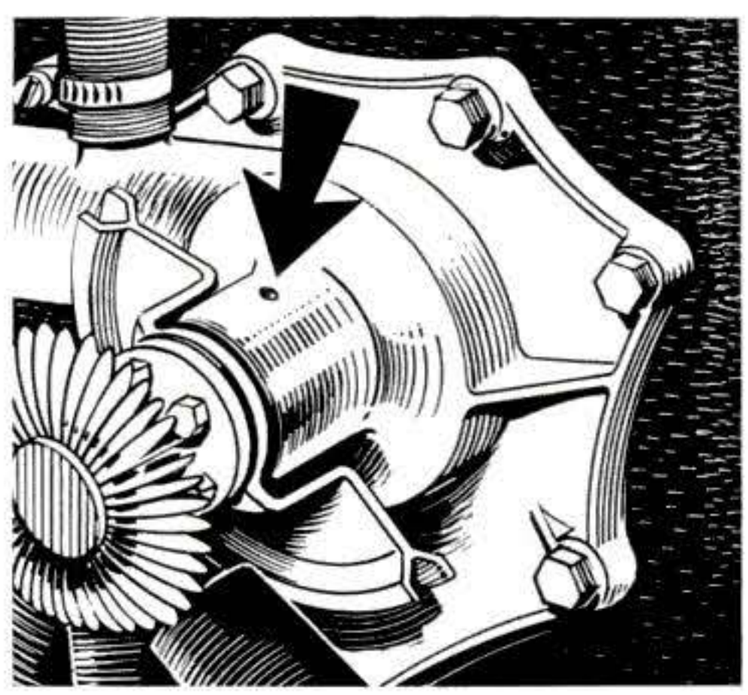
A new valve for a new tire

Replacing a worn-out tubeless tire with a new one? Make sure a new tire valve is installed, too. A valve deteriorates with age, just as a tire does. If you don't replace it, it may start to leak, resulting in under-inflation, shorter tire life, and maybe a flat.



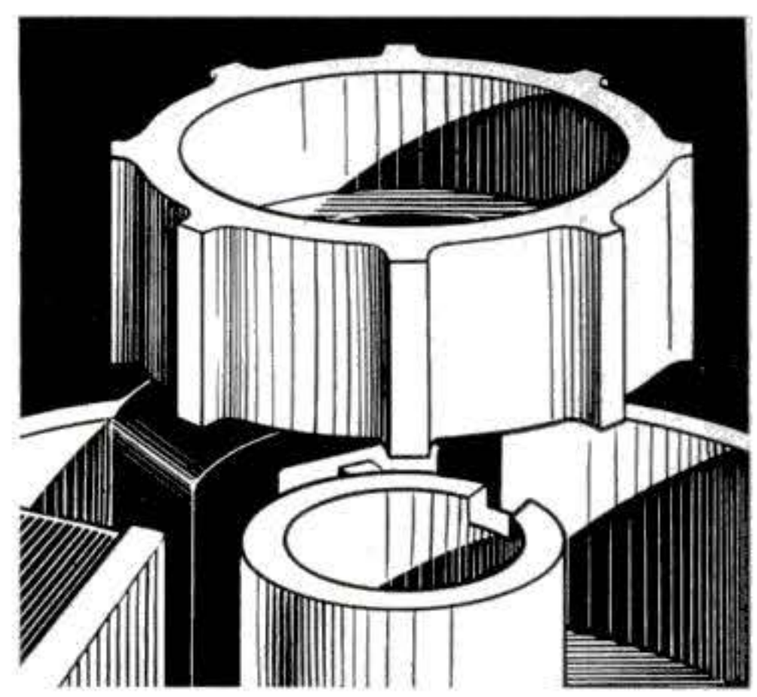
Checking for battery drain

Even when the ignition switch is off, dirt on top of your battery can complete a circuit from positive terminal to ground—allowing the battery to drain. A voltmeter will let you quickly determine whether you're losing current across the battery top. Touch the positive lead to the positive battery post, and the negative lead to different points on the battery case. If you read any voltage, clean the battery.



Replacing a water pump

When you've installed a new water pump, fill the cooling system before you start the engine. Operating the water pump dry for even a few seconds can damage the seal and cause early failure of the water pump. Traces of moisture, by the way, at the water-pump vent should not be considered as seal failure unless you can determine that coolant is being lost from the cooling system.



Crossfiring in some engines

Chrysler 400 and 440 engines for 1977 with electronic lean burn use an electronic instead of a centrifugal advance. Sometimes a crossfire condition may occur, resulting in misfiring, backfiring, or engine bucking. The cure is quick and simple—a new reluctor (part #4091277). This changes insert alignment of the rotor five degrees to minimize crossfiring. Retime the engine when the reluctor is installed.

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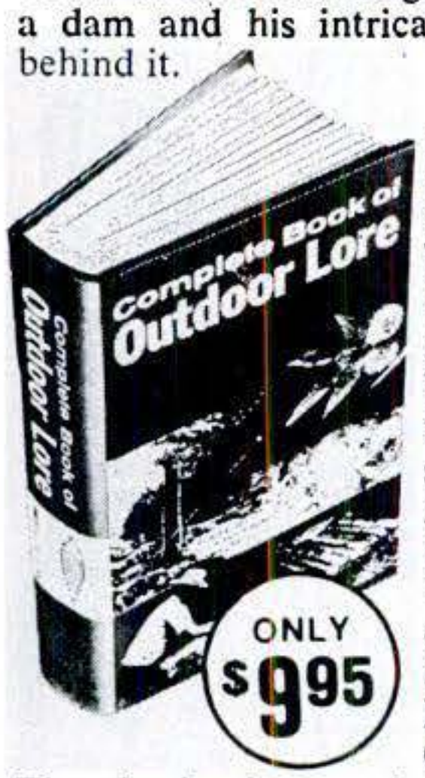

Yes, if you know what to look for, you can spot not just the beaver's dam but the flattened grass that was a deer's bed, the broken saplings and trampled earth that say two bull moose fought here, a tree trunk stripped of bark by a hungry cottontail rabbit. It's all in the COMPLETE BOOK OF OUTDOOR LORE! The fascinating section on animal signs and tree identification gives you the knowledge you need to enjoy the outdoors whether you're camping out for a week or just enjoying a Sunday stroll. *And, this is just the frosting on this amazing book of outdoor wisdom and know-how!*

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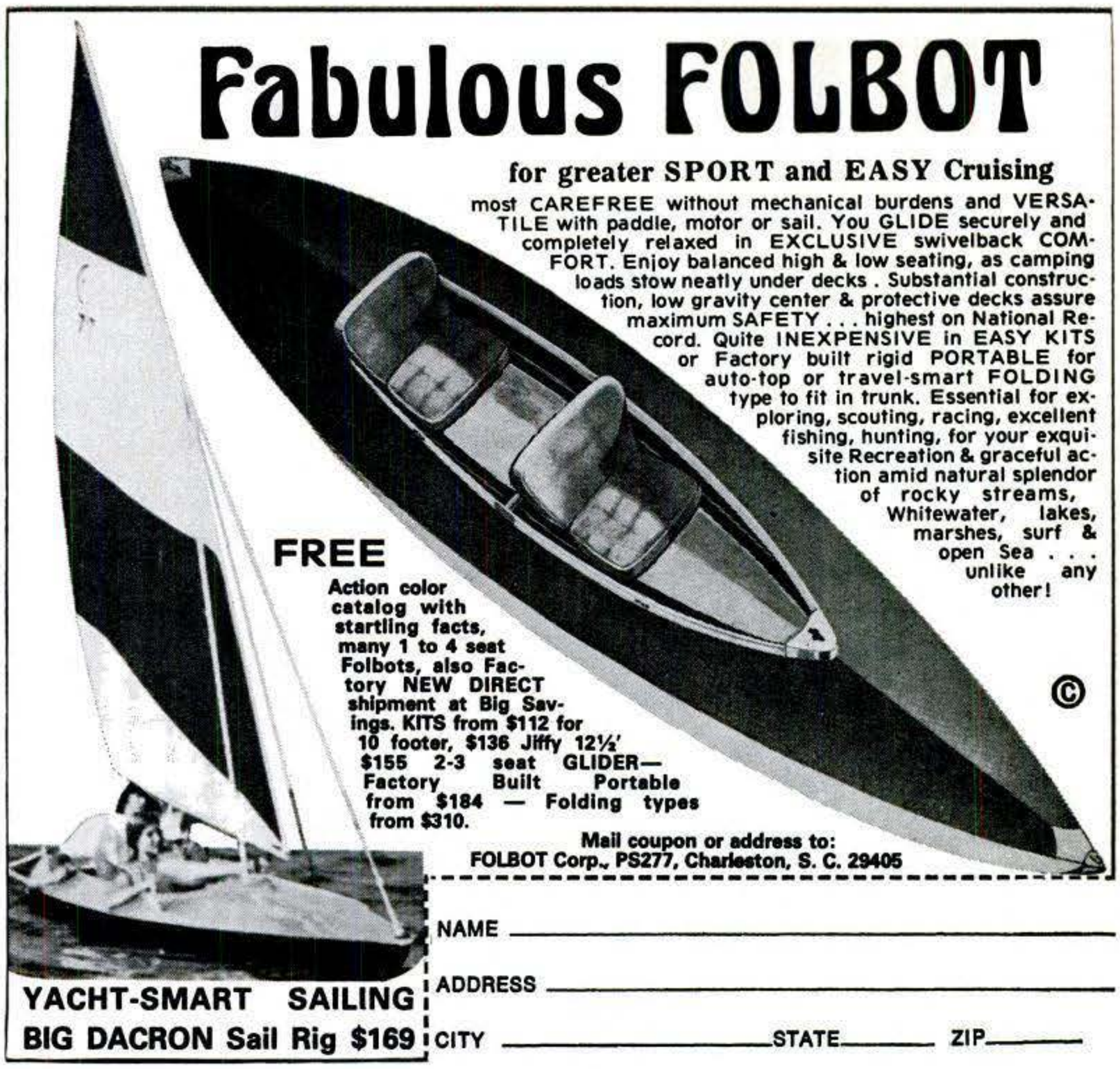

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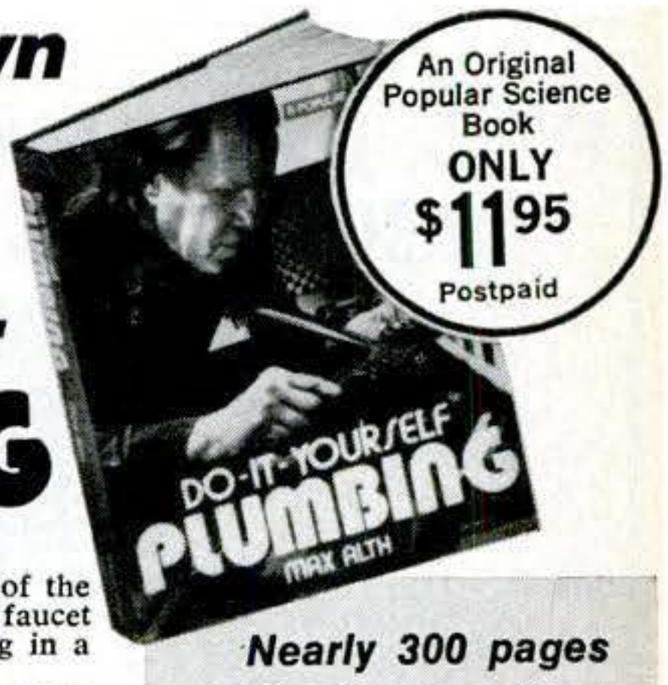

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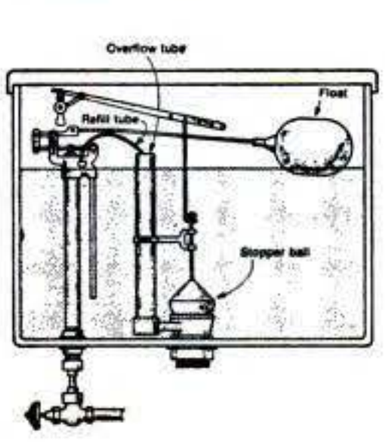

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In a typical setup, workers would arrange their own schedules, provided that their total hours fall within set limits. Employees must also be on the job during "core periods" before and after lunch. Such flexibility, studies have shown, reduces absenteeism and employee turnover, and boosts productivity.—*John Free*

Inquiry station displays an employee's current work record when a coded card key used to clock in and out of work is inserted in a reader.

Computer-based Multi-Tyme system records flexible hours. Processor (left) feeds data to payroll system; CRT display and printer are at right.

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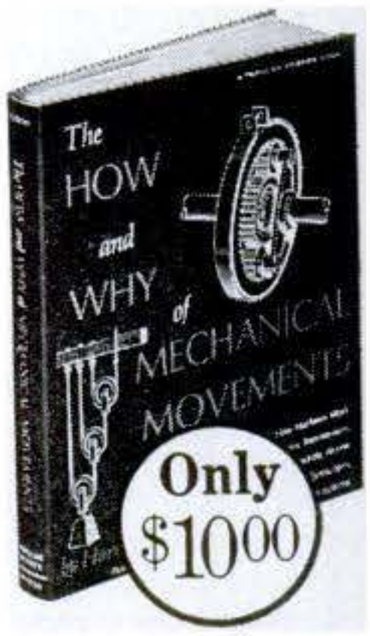

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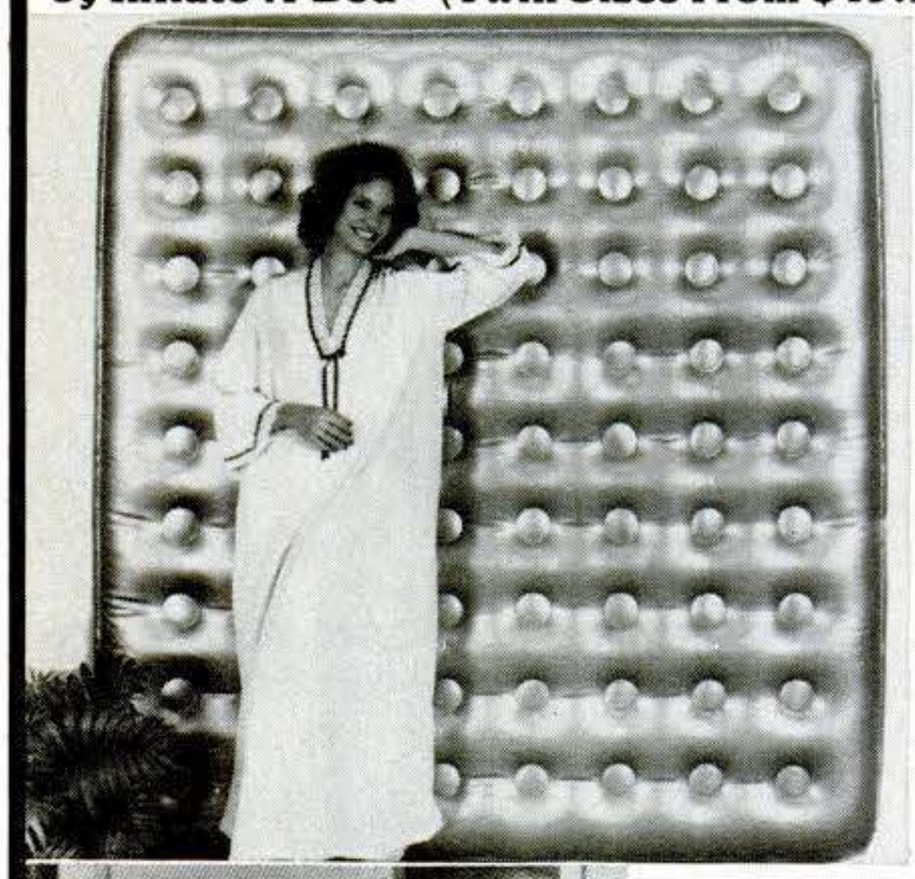

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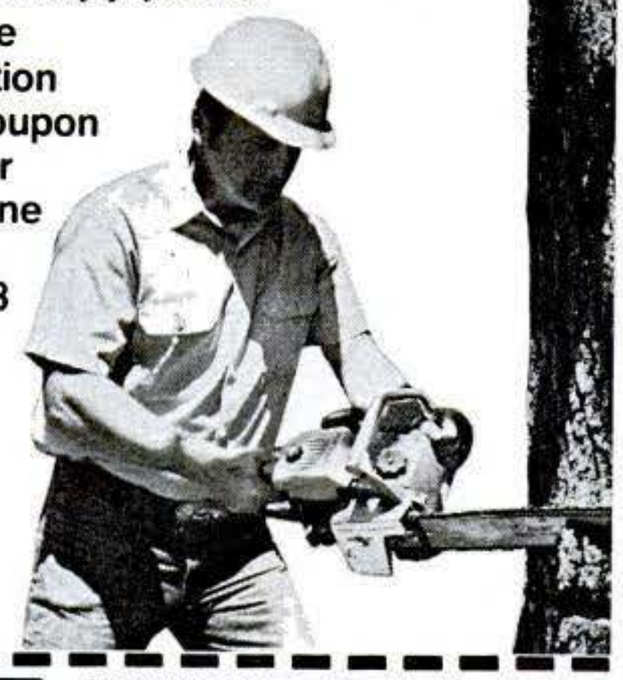

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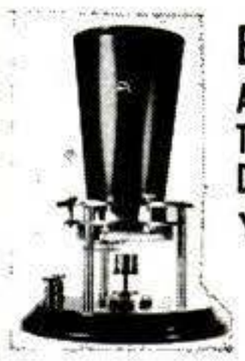

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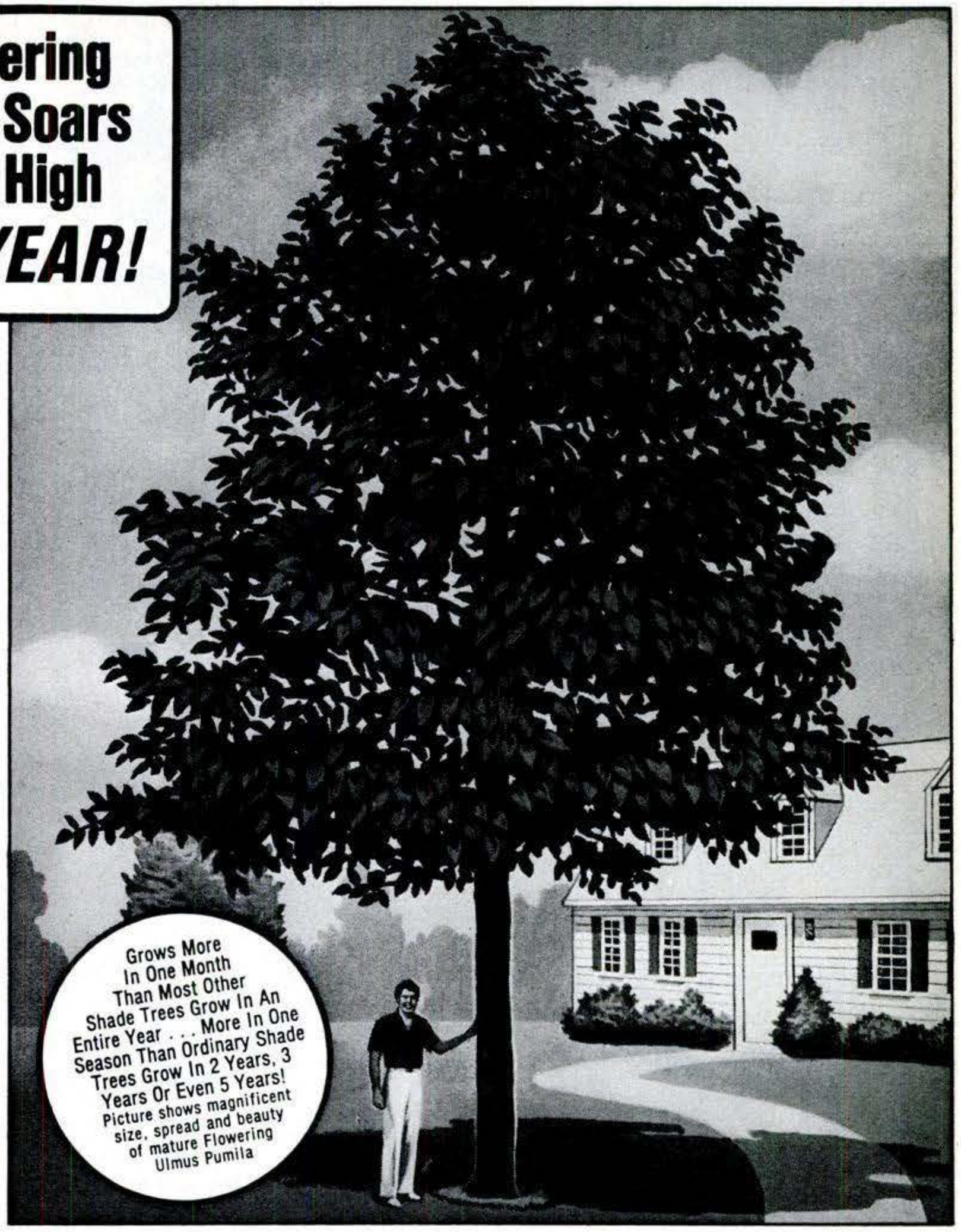

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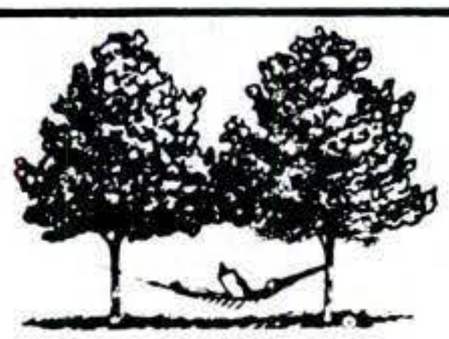

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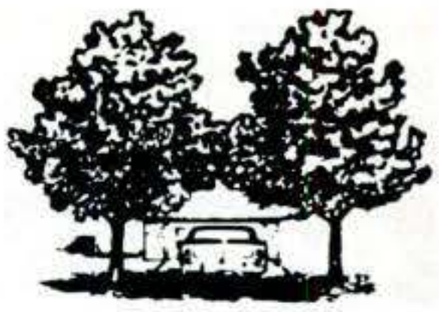

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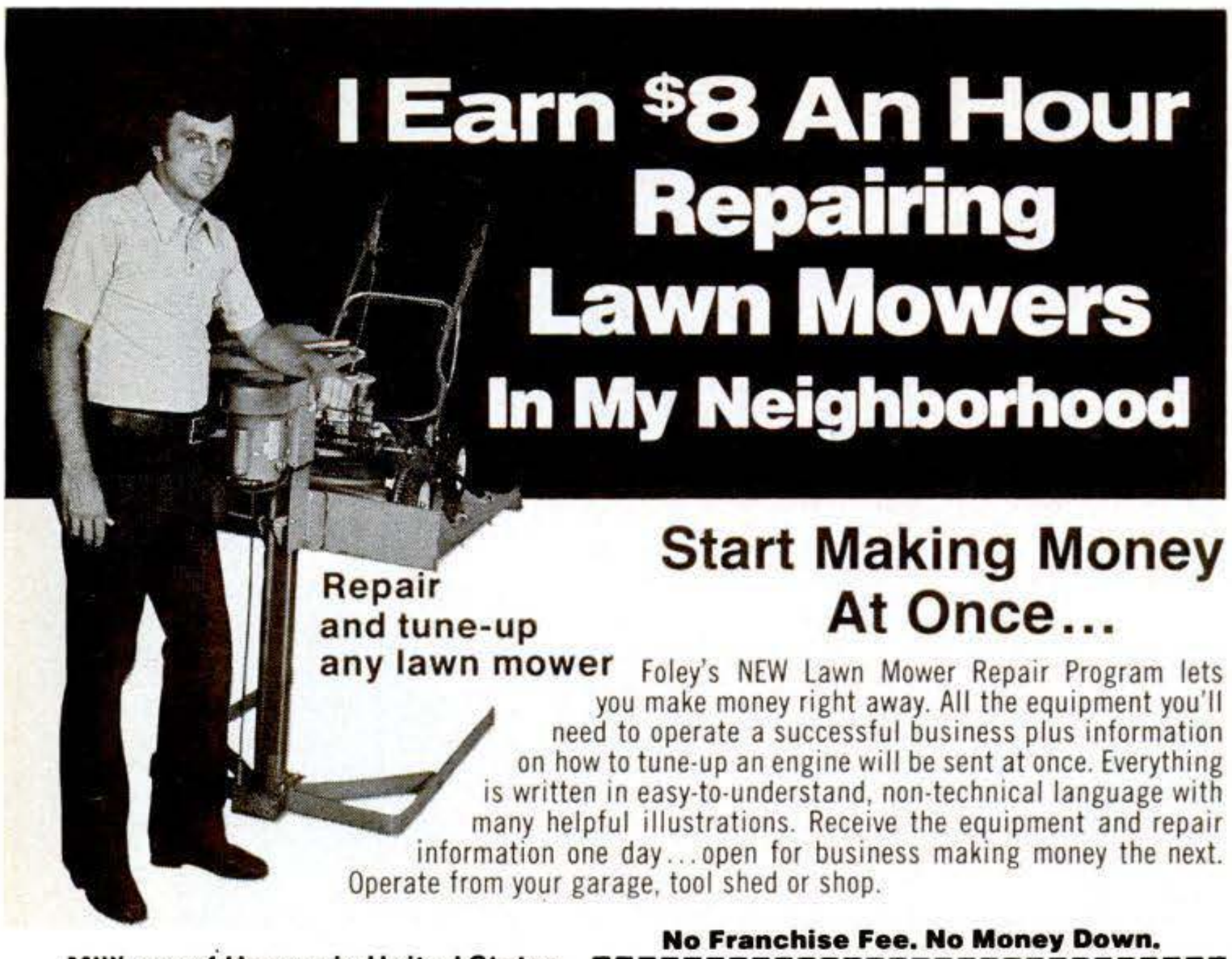

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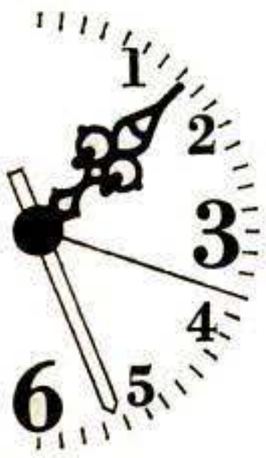

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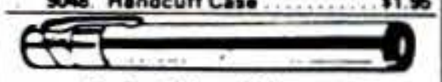

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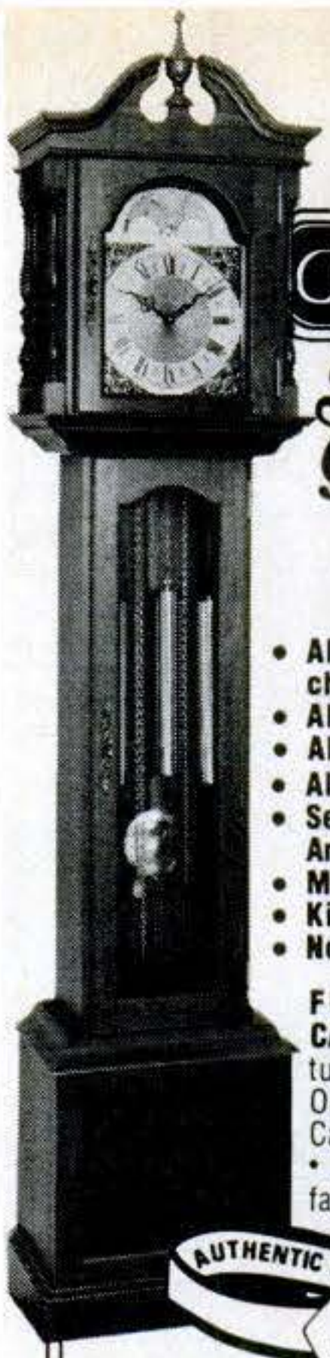

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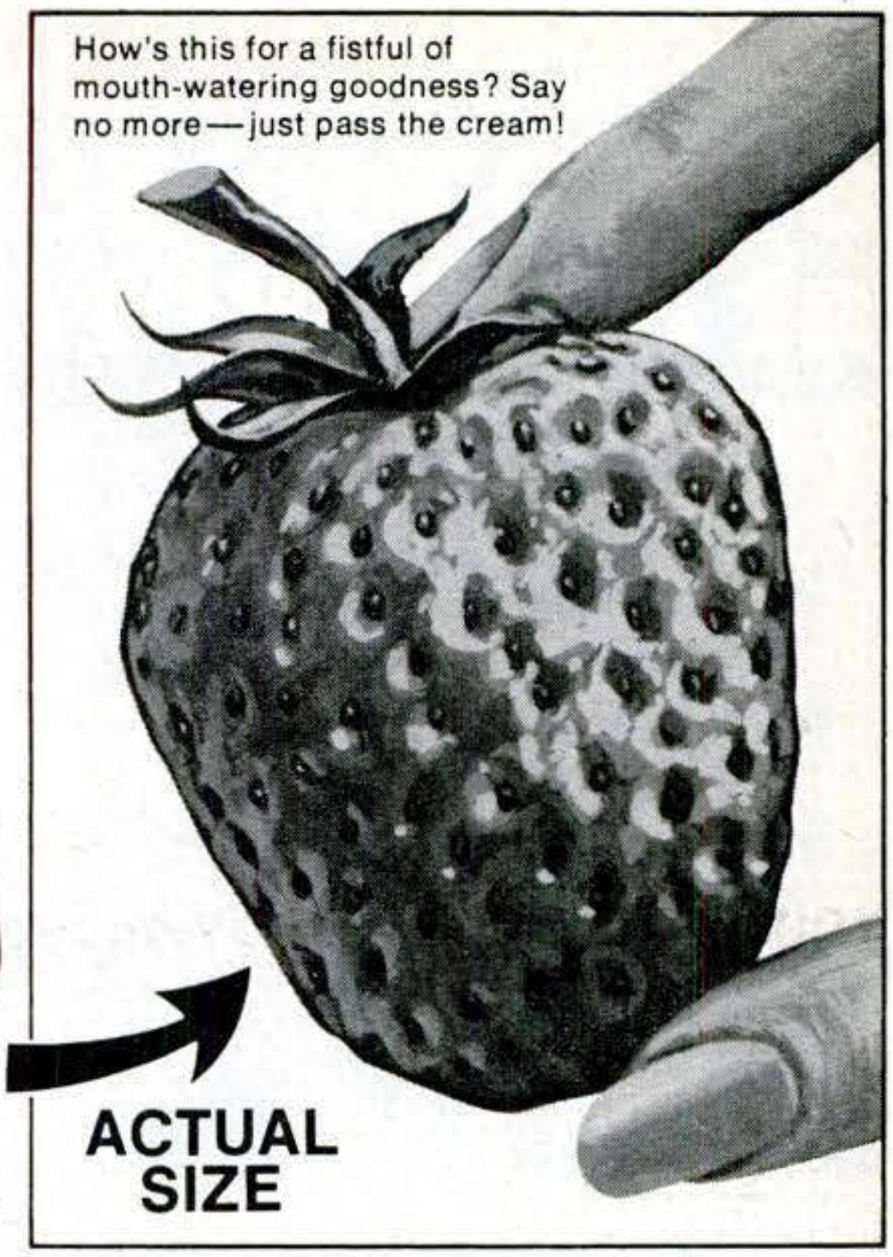

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Think of it! An entire hanging garden of "WINTER-THRU-SUMMER" indoor strawberries that grow into a wondrous indoor orchard just teeming with basket-after-basket of the sweetest, juiciest berries you've ever sunk your tooth into.

HUGE "RESTAURANT" TYPE BERRIES TWICE AS BIG, TWICE AS TASTY AS REGULAR OUTDOOR STRAWBERRIES!

And not just ordinary strawberries, but giant RECORD-BOOK fruits that look like small peaches. Yes, yours ALL WINTER LONG and ALL SPRING TOO — a summertime feast of berries by the basketful that are:

- SO BIG and juicy you eat them like hand-fruit . . . just like peaches or plums.
- SO HUGE and meaty, just one sliced-up berry tops a whole bowlful of cereal.
- SO PROLIFIC that for every giant berry you pick when it first fruits, you'll pick 2, 3, even 4 times as many as the months go by!

THINK OF IT — FROM THIS ONE SINGLE PLANT, YOU GET A WHOLE WINTER-THRU-SUMMER "STRAWBERRY FACTORY"

Just imagine the taste thrills galore as you "spoil" yourself and your family with FRESH-PICKED STRAWBERRIES from your own indoor hanging garden ALL WINTER LONG, ALL SPRING LONG, **smack up to summer starting just weeks from now!**

FOR BERRIES BY THE BUSHEL ALL WINTER, ALL SPRING — ACT NOW!

Now, the price of these wondrous INDOOR-FRUITING STRAWBERRIES is not the $3.00 or $4.00 per plant you might expect . . . just a mere $2.98 for the entire 3-Plant Hanging Garden, PLANTER INCLUDED. And remember — the plants we send you are true fruiting-size, nursery grown stock . . . all set to reward you with berries by the basketful . . . berries almost the size of SMALL PEACHES . . . starting just 60 days from today! But since now is the time they must be shipped if you want a parade of sweet, fresh strawberries starting this very winter from your own INDOOR HANGING STRAWBERRY GARDEN (and continuing right through spring and smack up to summer) . . . you must act NOW!

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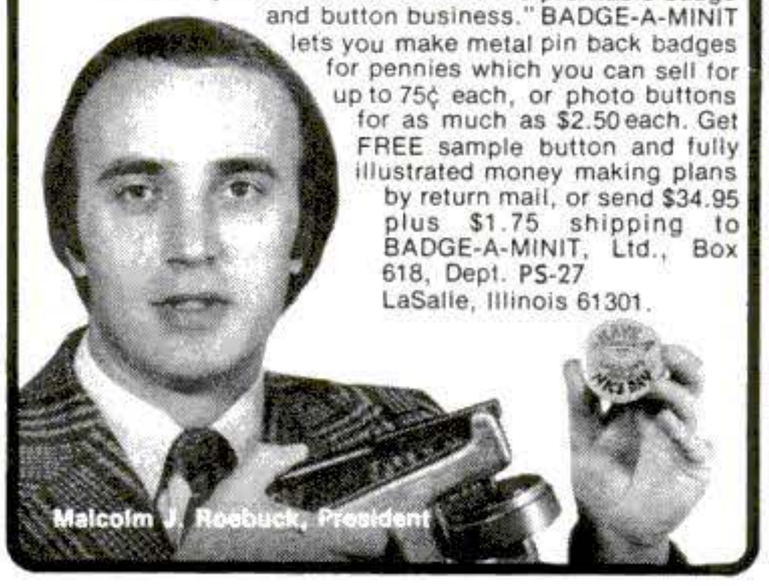

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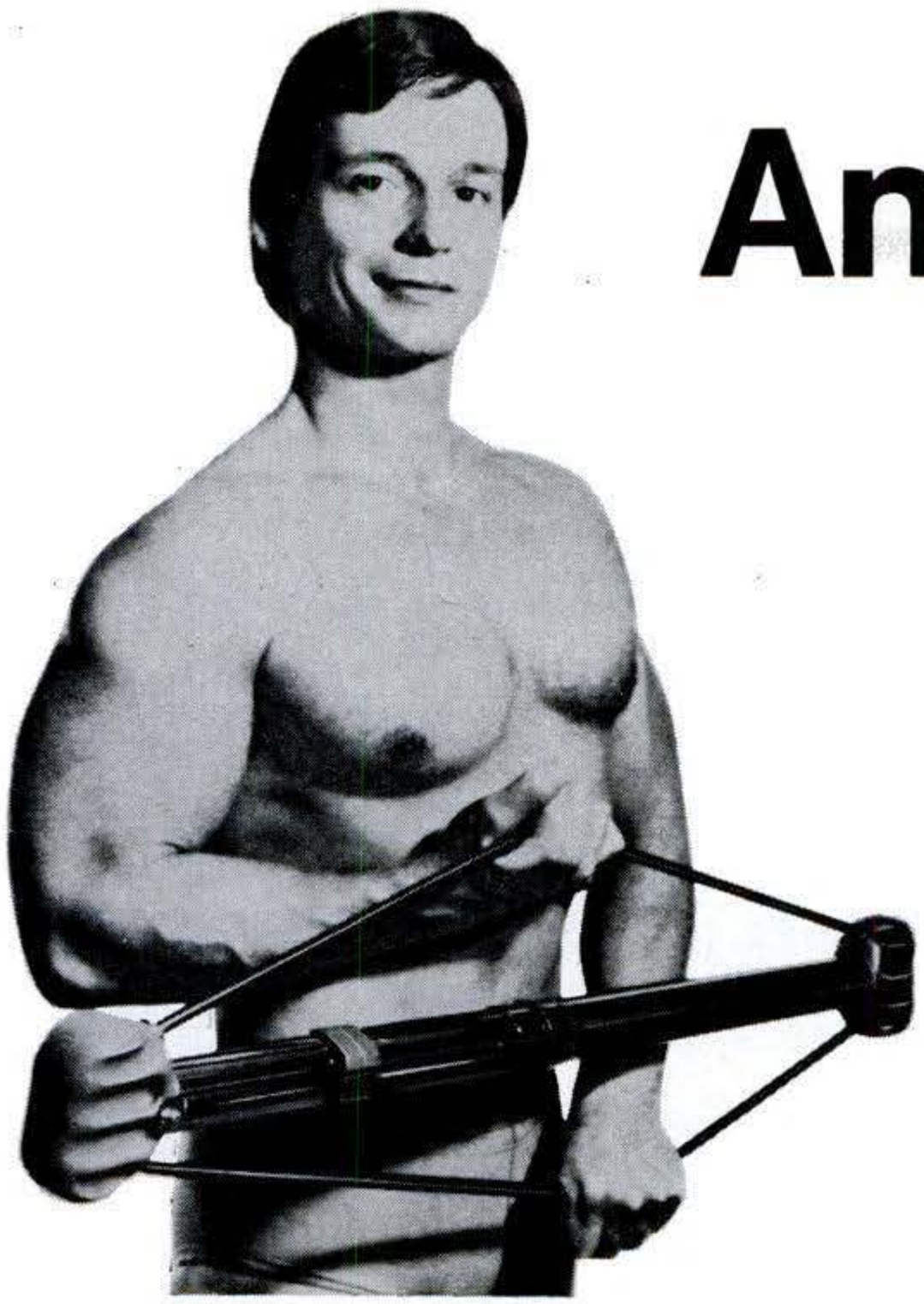

An expert tells you how to get back in shape!

Our files show that thousands of men want to get back in shape, but don't know how to go about it. We decided to ask an expert, Mike Fretault, leading fitness authority. Here are his answers.

Q. How can I get back in shape?

A. There is only one answer to that: get more exercise.

Q. Won't sports do the trick?

A. Sure, sports are great, provided you practice a "complete" sport like jogging, swimming or rowing a few hours every week. Unfortunately, most men don't have the time or energy for that.

Q. How about calisthenics?

A. Also very good, but even a beginner's program should comprise at least 200 to 300 repetitions. Most men find calisthenics tiring and boring and give up after a few workouts.

Q. Isn't there an easier way?

A. There is one outstanding home training method I use and recommend. It's fast, it's easy and it keeps you interested because during every workout you actually see your strength increasing on the built-in Powermeter gauge.

Q. What's it called?

A. Bullworker® training. It's based on Isometric techniques which have been proven to increase strength three times faster than conventional methods.

Q. How long does it take?

A. The introductory "get back in shape" program requires only 70 seconds of exercise per day. The complete advanced training program takes about 5 minutes.

Q. What kind of results can I expect?

A. After 2 or 3 weeks of introductory training, most men can see an increase in strength of around 10% and measure an extra inch or two of muscle on their shoulders, chest, biceps—and an inch or two less flab around the waist.

Q. But it's hard work, isn't it?

A. Absolutely not. Most men between 15 and 65 in good general health can run through the full program without getting tired. Bullworker training is progressive so you perform better each time, yet the training always seems easy to you.

Q. What can I expect from continued training?

A. The sky's the limit. There are specialized exercises for building-up or trimming down any part of your body you want to: broad, muscular shoulders —bulging biceps, powerful wrists and forearms—a deep, manly chest tapering down to a flat, trim waist—muscular thighs and calves. You can expect strength increases of up to 4% a week; that's 50% in just three months and I have seen many men go on to double and even triple their strength.

Q. How can I find out more about Bullworker?

A. I suggest you write for the Free Booklet in color. It contains complete details about Bullworker training and tells you how you can try a Bullworker for two weeks in your own home without cost or obligation.

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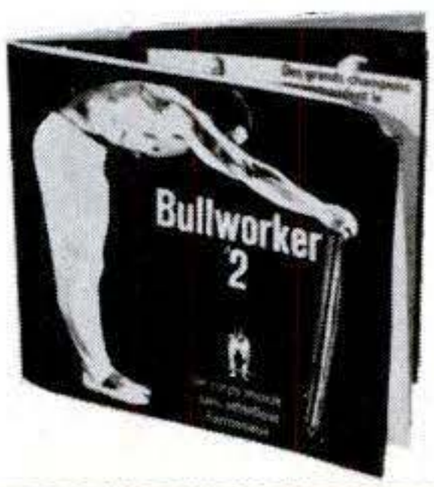

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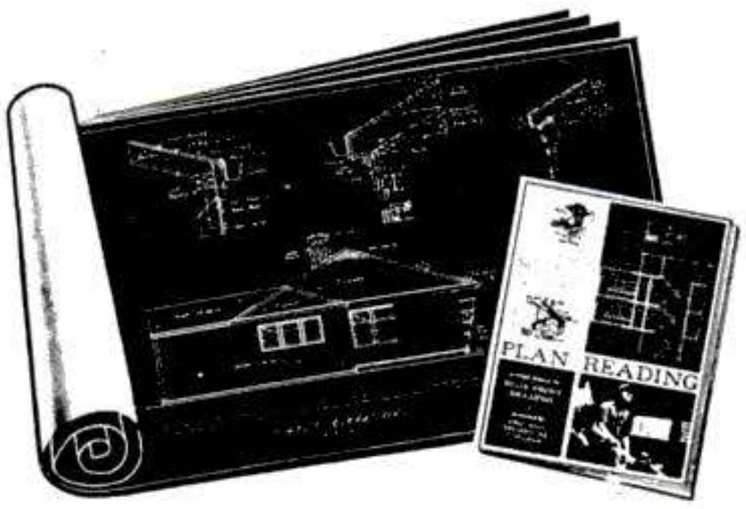

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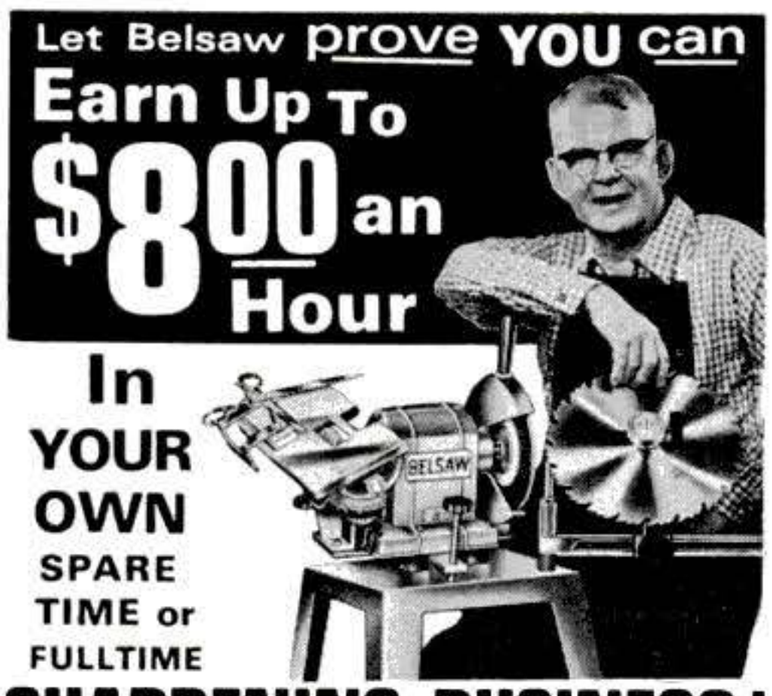

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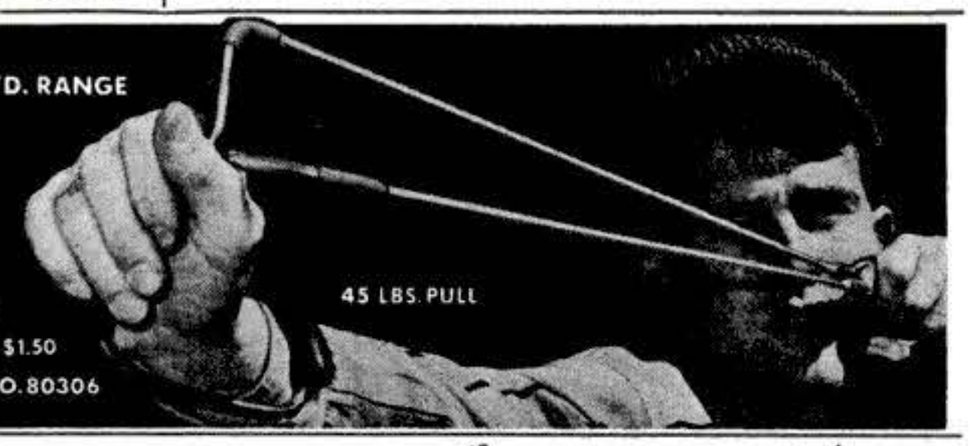

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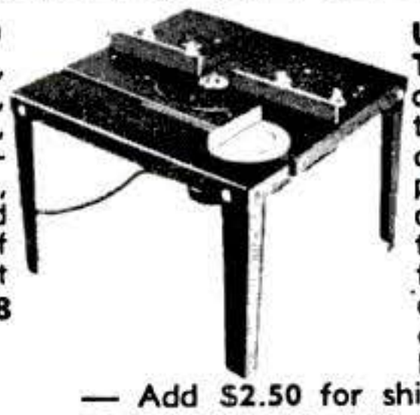

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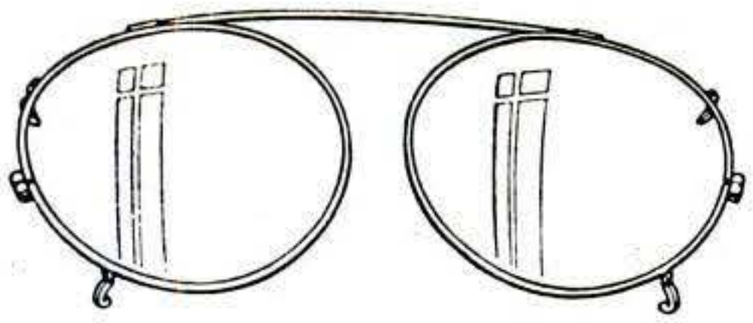

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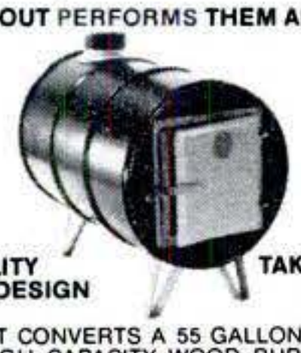

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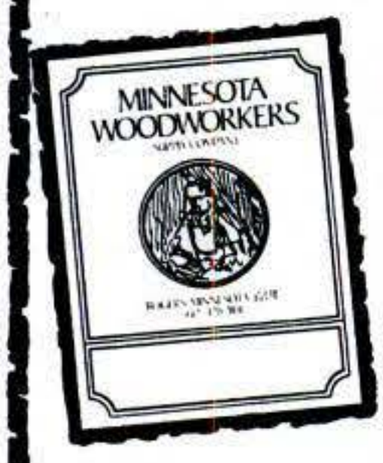

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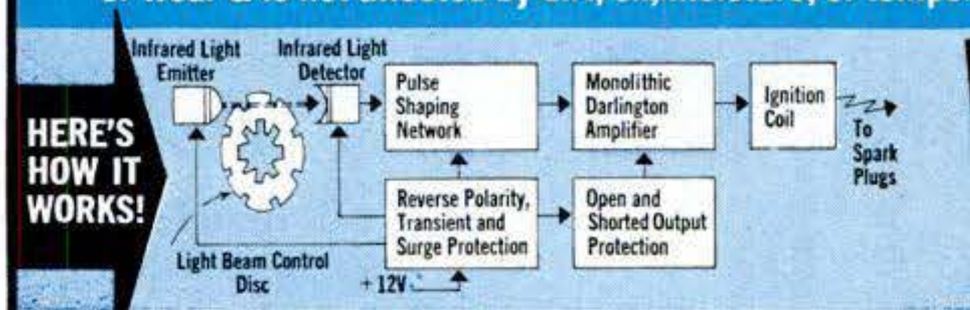

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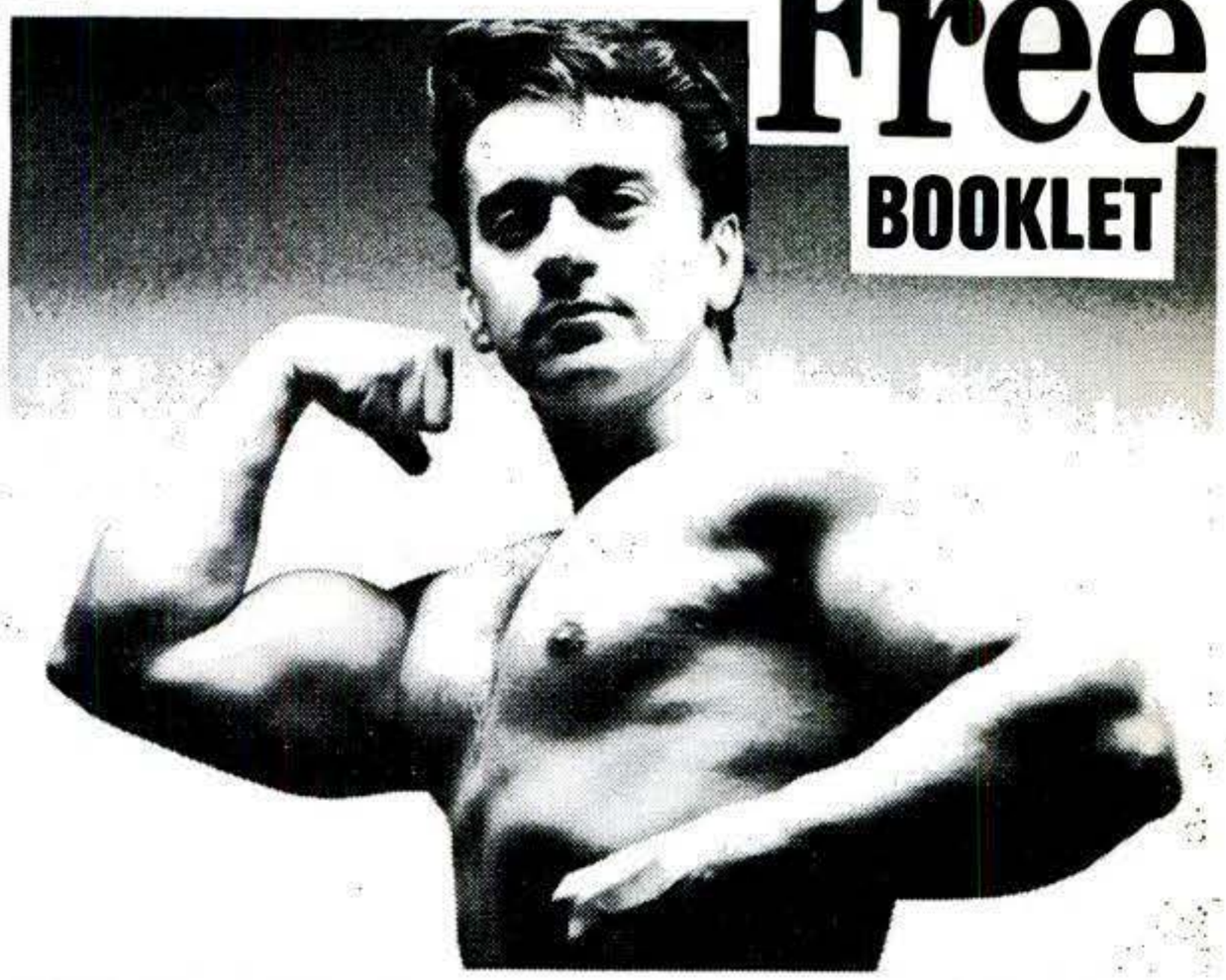

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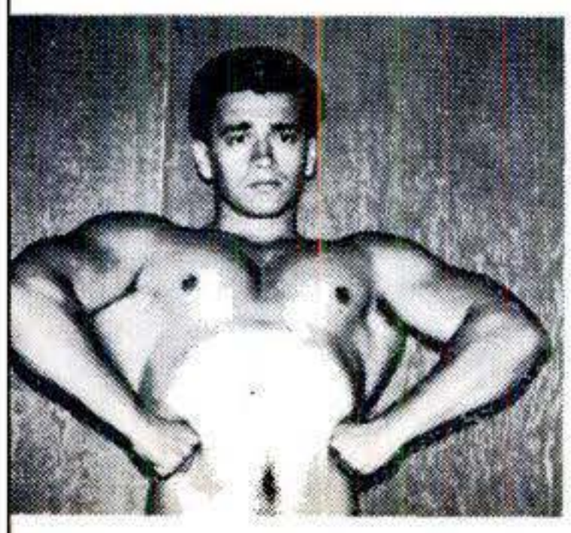

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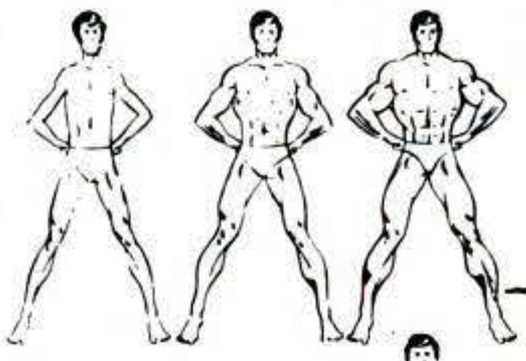

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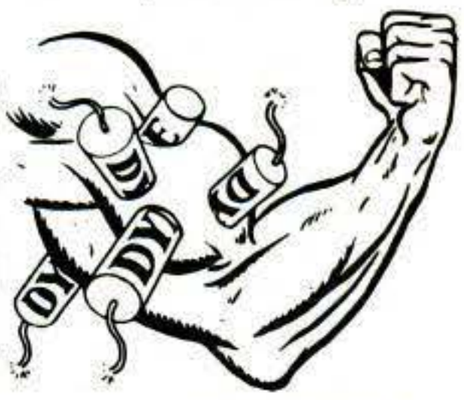

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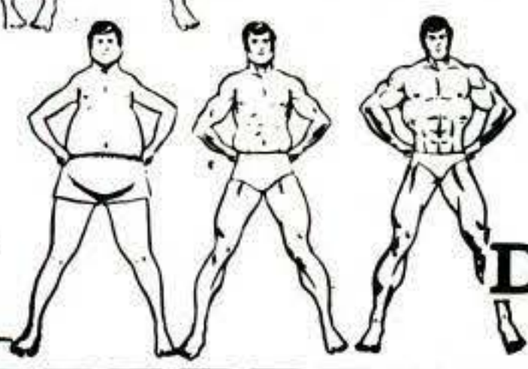

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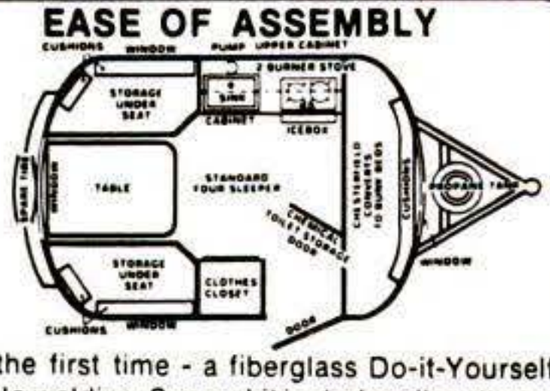

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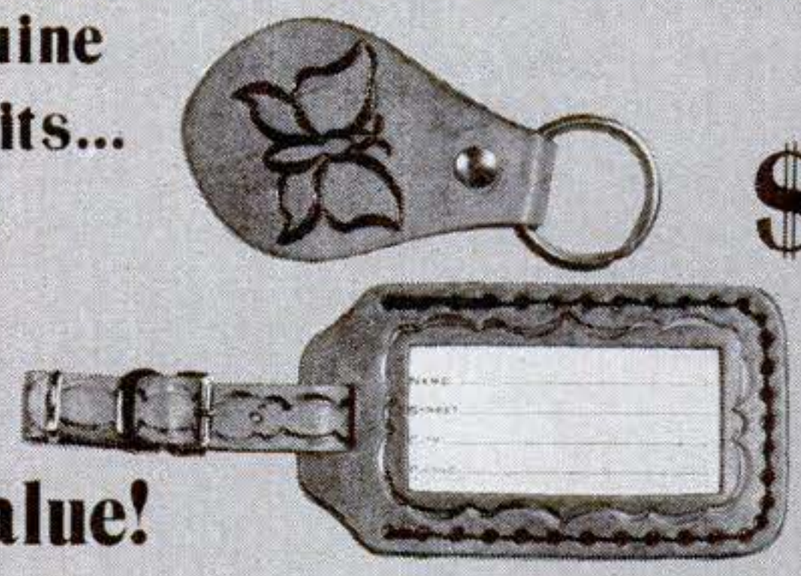

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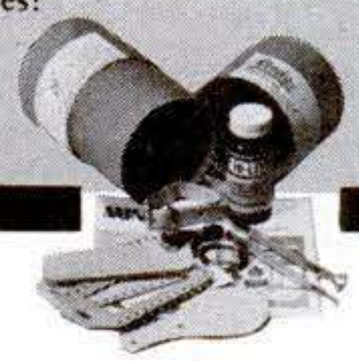

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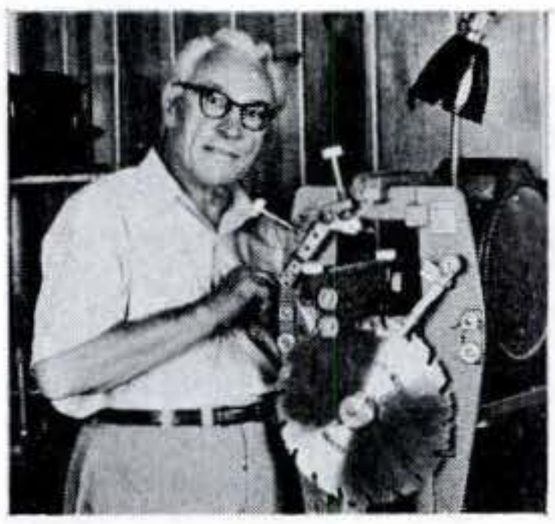

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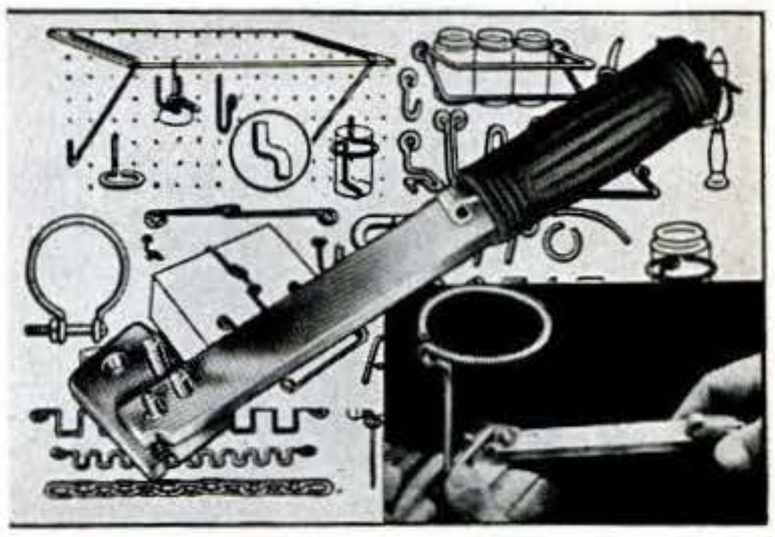

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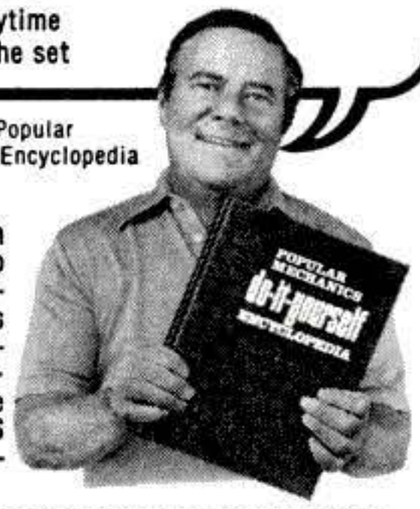

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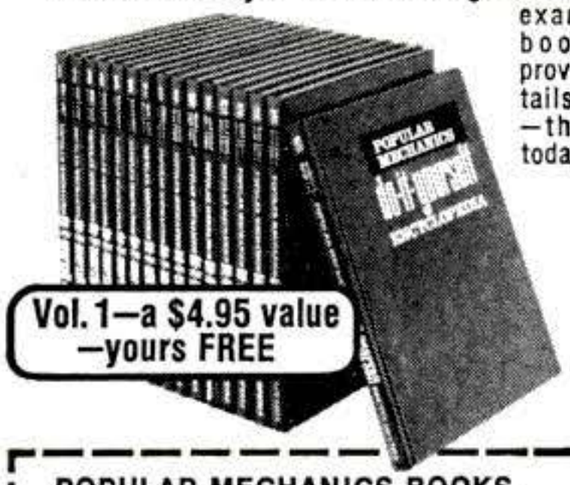

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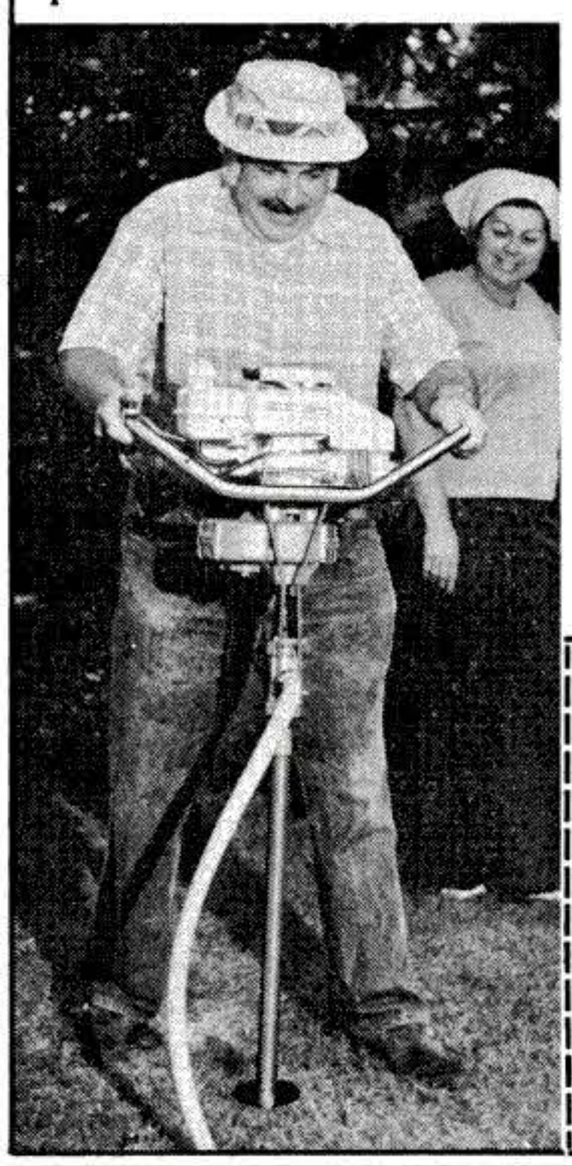

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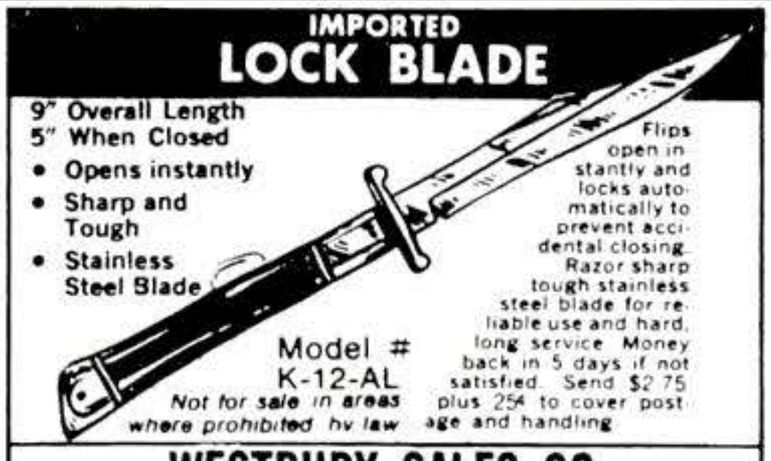

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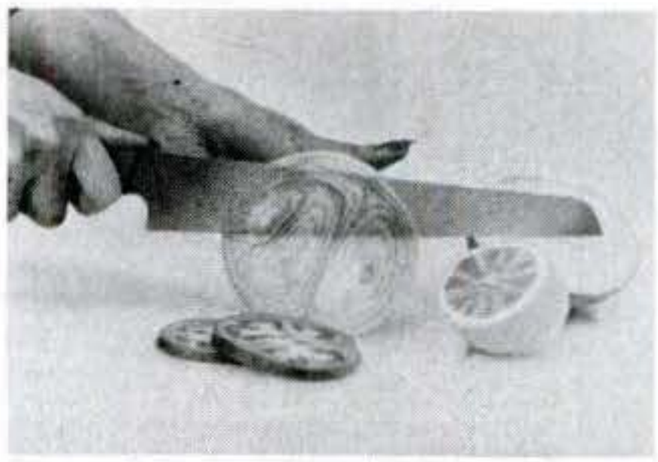

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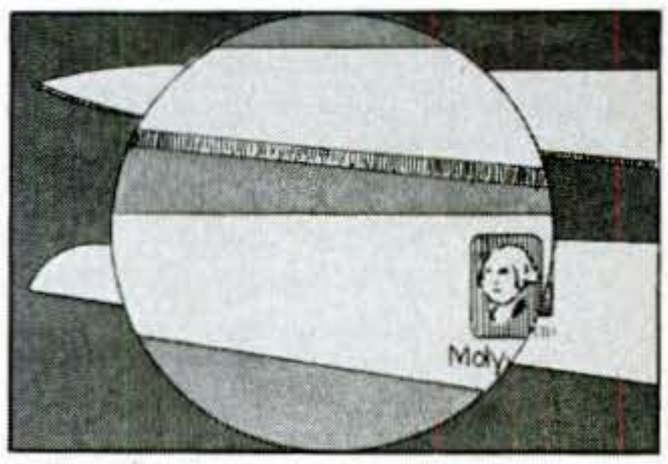

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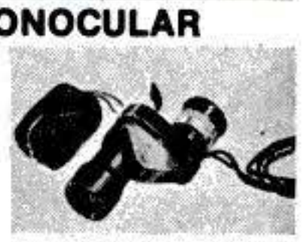

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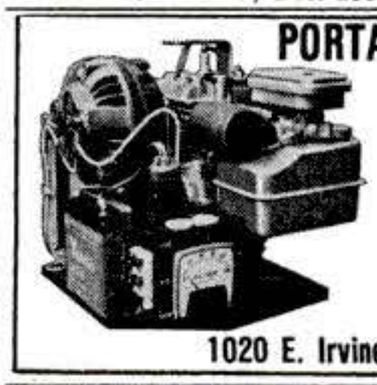

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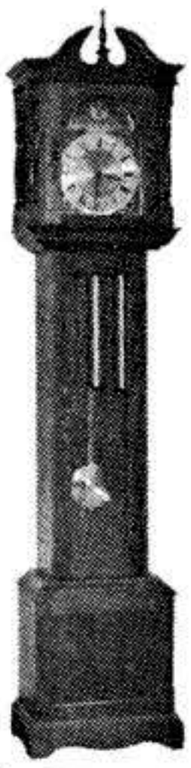

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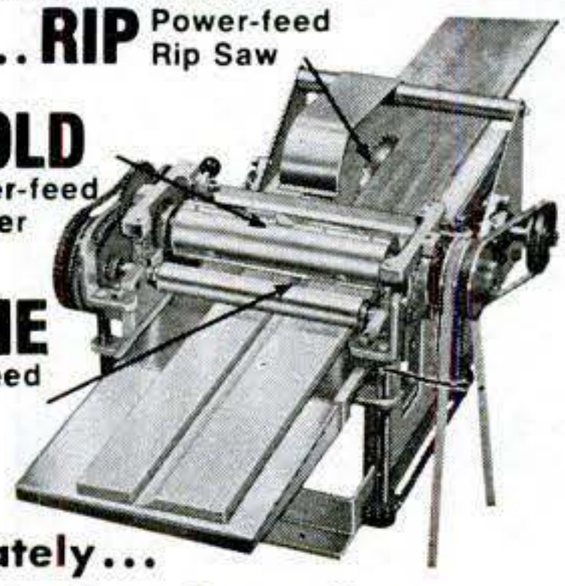

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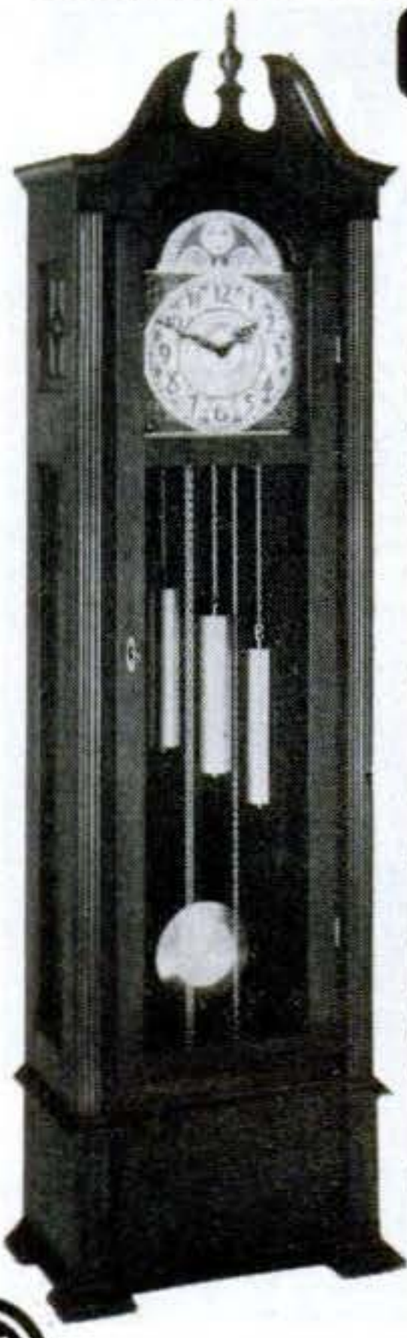

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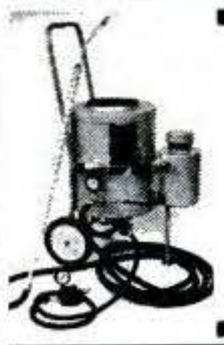

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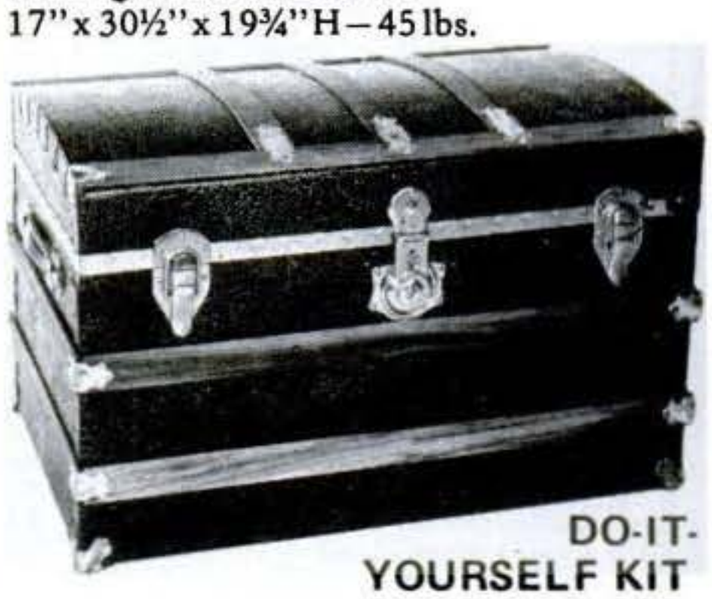

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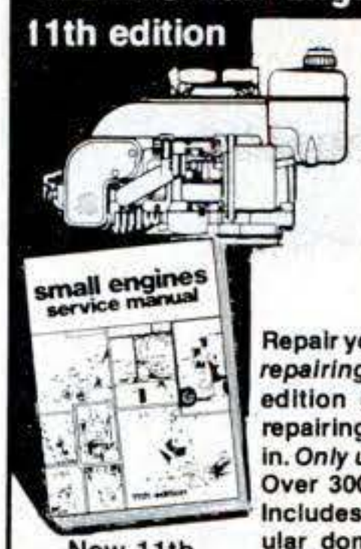

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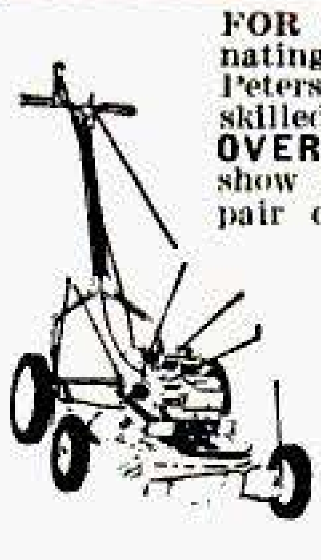

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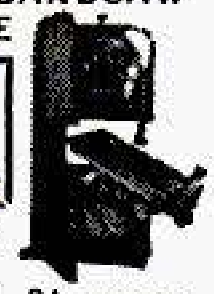

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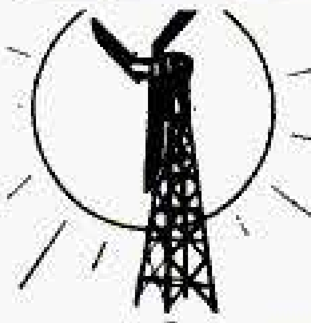

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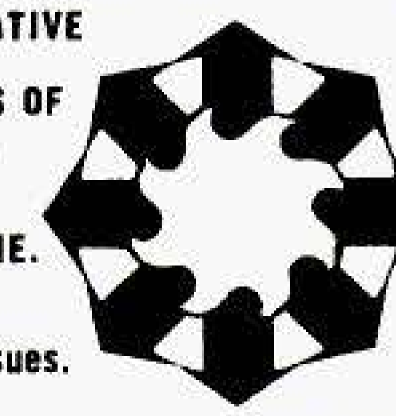

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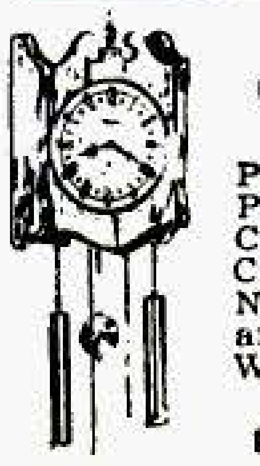

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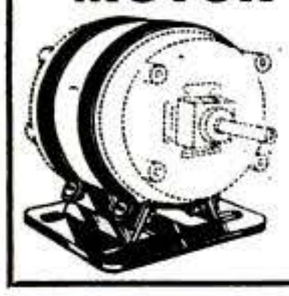

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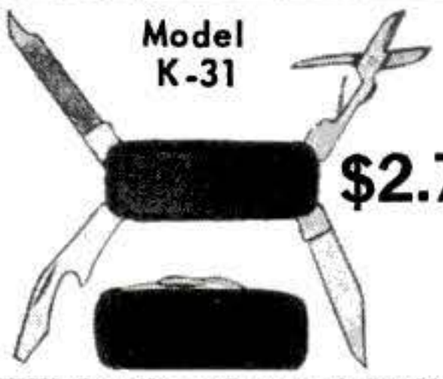

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PORTABLE Pantry Plans $2. Debrus, 6032 Sydney Drive, Huntington Beach, CA 92647.

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FREE Catalogue! Thousands war surplus optical bargains. Lenses, Prisms, Telescopes, Binoculars, etc. Jaegers, 691G Merrick Road, Lynbrook, NY 11563.

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"U.S. GOVERNMENT SURPLUS Directory," How, Where to Buy. 100,000 items (including Jeeps) . . . Low as 2c on Dollar! Most Complete Information Available . . . $2.00. SURPLUS DISPOSAL, Box 19107-FB, WASHINGTON, DC 20036.

1977 SURPLUS Army, Navy store 64 page illustrated catalog. Send $1.00. Ruvel, 3037 N. Clark, Dept. 2M, Chicago, IL 60614.

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GOVERNMENT Surplus, How and where to Buy in your Area, send $2.00. Surplus, 30177-PS HEADQUARTERS BUILDING, Washington, D.C. 20014.

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HOW to Make Money Writing Short Paragraphs. Information Free. Barrett, Dept. C-86-B, 6216 N. Clark, Chicago 60660.

FREE Literature — Make Big Money Raising Fishworms and Crickets. Carter Farm-10, Plains, GA 31780.

FREE catalog. Repair air conditioning refrigeration. Tools, supplies, full instructions. Doolin, 2016 Canton, Dallas, TX 75201.

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CLOCK and Watch Repairing Books, Tools, Materials. Free catalog. North American, Box 77BBA, Fox River Grove, IL 60021.

HUNDREDS Books Catalog 25c. Fleischer, 129 Walnut Street, Everett, MA 02149.

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FREE Discount Book List. Senrab, 1454 W. 73rd Place, Chicago, IL 60636.

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PROFESSIONAL Magic, Giant Illustrated Catalog 25c. Top Hat-B, Box 1669, Evanston, IL 60204.

WORLD'S Leading Professional Magic and Joke Catalog. Amaze, Mystify Friends. Huge Catalog 25c. Abracadabra-SP, Rahway, NJ 07065.

VENTRILOQUISM! Guaranteed Instruction, Scripts, Puppets. Catalog 25c. Maher, Box 420PS, Littleton, CO 80160.

TWO! Different Magic Catalogs 25c. Miami Magic, 9734 Bird Road, Miami, 33165.

FREE Trick and Catalog — 25c. Magic & Fun, Box 1936SP, New York, NY 10017.

MAGIC! Large combination professional and amateur catalog, 50c — refundable. Order from old, reliable dealer. Fast service. Jeffries Magicland, P.O. Box 274-B, Dallas, TX 75221.

BE A Magician! Two Booklets explaining 156 tricks Plus large Professional Catalog $2.00 (refundable). Magic, Inc., 5080 Lincoln, Chicago, IL 60625.

HUGE! Completely New Photographed Illustrated Magic Catalog 25c Moore's Magic, International, Box 1405-G2, Plymouth, MI 48170.

PROFESSIONAL Magic! Factory Direct to You. Giant Catalog — $1.00. (refundable). Hank Lee's Magic Factory, Dept. PS2, 24 Lincoln Street, Boston, MA 02111.

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LOOK! Fascinating Foreign Coins. Three For 10c. Goodwill Coins, 15037 Lapalm, OakForest, IL 60452.

FOUR Buffalo Nickels, Coin List, $1.00. Economy, Box 92, Buzzard's Bay, MA 02532.

25 OLD Mercury Head Dimes, $14.95. The Coin House, Liberty Bank Building, Suite 108, St. Paul, MN 55104.

BUFFALO Nickels, Five Different $1.00. Bryson, 612P White, Toledo, OH 43605.

SEND 10c for new edition valuable Guidebook "How to Collect Coins." Also included 5 foreign coins from Turkey, Spain, etc., and best coins and supplies catalog in America. Littleton Coin Company, Dept. XB-2, Littleton, NH 03561.

INDIANHEAD & Lincoln Cents 1883-1949, 33 Different $2.99. Catalog 25c. Edel's, Carlyle, IL 62231.

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200 WORLDWIDE Stamps 25c. Approvals. White, Box 24211, Indianapolis, IN 46224.

RUSSIAN Apollo-Soyuz set 25c with Approvals from Richard Thorne, 13317 Lydia Street, Silver Spring, MD 20906.

50c BRINGS 100 pictorials and worldwide approvals. Capt. Shaw's, Box 277, Ocean Park, Maine 04063.

FREE Mammoth Collection, Scott's, Master Global Albums When You Buy Approvals. Bargain Stamps, Box 5345, Santa Ana, CA 92704.

INEXPENSIVE Packet Approvals. $1.00 Deposit, Refundable. Fies, A6U, Thornville, OH 43076.

FREE duplicate exchange—2c approvals Belden, Box 4175, Dearborn, MI 48126.

140 Different U.S. commemoratives with approvals $1.25. Carstamps, Box 6101, Fort Smith, AR 72906.

FREE! Beautiful Nudes Collection. Approvals, Banknotes. Summit, 1146C 49th, Brooklyn 11219.

FREE U.S. Mint Set. Approvals. Hildebrand, Box 5645, Redwood City, CA 94063.

$2.00 PACKET given approval buyers. Gaines, Box 788, Mattoon, IL 61938.

50 SPORTS PICTORIALS — 35c. Approvals, Arbour, 3727 Downey Dale, Randallstown, MD 21133.

FIRST Day Covers on Approval. Dolores, Box 96PS, Coopersburg, PA 18036.

FREE Surprise collection sent with approvals. Jay, 1784 Union, San Francisco, 94123.

50 DIFFERENT Old U.S. Revenue Stamps $1.00. Winchester Stamps, Box 3592, Mansfield, OH 44907.

"MARS CONQUEST" — 15c with Space approvals. Potomac Stamps, Washington, DC 20015.

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FREE! Big Bargain Catalog — New Edition listing thousands of bargains including U.S. and B. N. A. stamps, packets, albums, accessories and supplies. Also, fine stamps from our approval service which you may return without purchases and cancel service at any time. Jamestown Stamp, Dept. E-27-PS, Jamestown, NY 14701.

FREE: 32 Page United States and United Nations Price List. Shelron, Box 610547K, North Miami, FL 33161.

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"INVERTED ERROR"—Hammarskjold, 15c with Approvals. Belmont Stamps, Washington, DC 20015.

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CLOCK and Watch Repairing Books, Tools, Materials. Free catalog. North American, Box 77BBA, Fox River Grove, IL 60021.

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FREE duplicate exchange—2c approvals Belden, Box 4175, Dearborn, MI 48126.

140 Different U.S. commemoratives with approvals $1.25. Carstamps, Box 6101, Fort Smith, AR 72906.

FREE! Beautiful Nudes Collection. Approvals, Banknotes. Summit, 1146C 49th, Brooklyn 11219.

FREE U.S. Mint Set. Approvals. Hildebrand, Box 5645, Redwood City, CA 94063.

$2.00 PACKET given approval buyers. Gaines, Box 788, Mattoon, IL 61938.

50 SPORTS PICTORIALS — 35c. Approvals, Arbour, 3727 Downey Dale, Randallstown, MD 21133.

FIRST Day Covers on Approval. Dolores, Box 96PS, Coopersburg, PA 18036.

FREE Surprise collection sent with approvals. Jay, 1784 Union, San Francisco, 94123.

50 DIFFERENT Old U.S. Revenue Stamps $1.00. Winchester Stamps, Box 3592, Mansfield, OH 44907.

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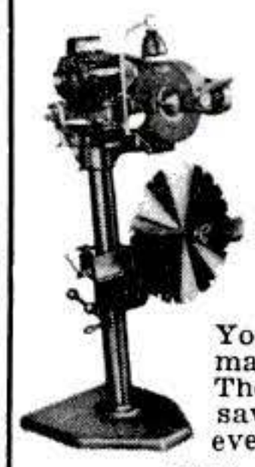

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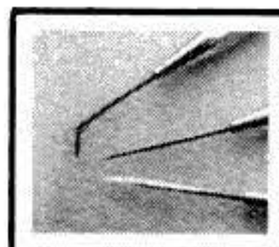

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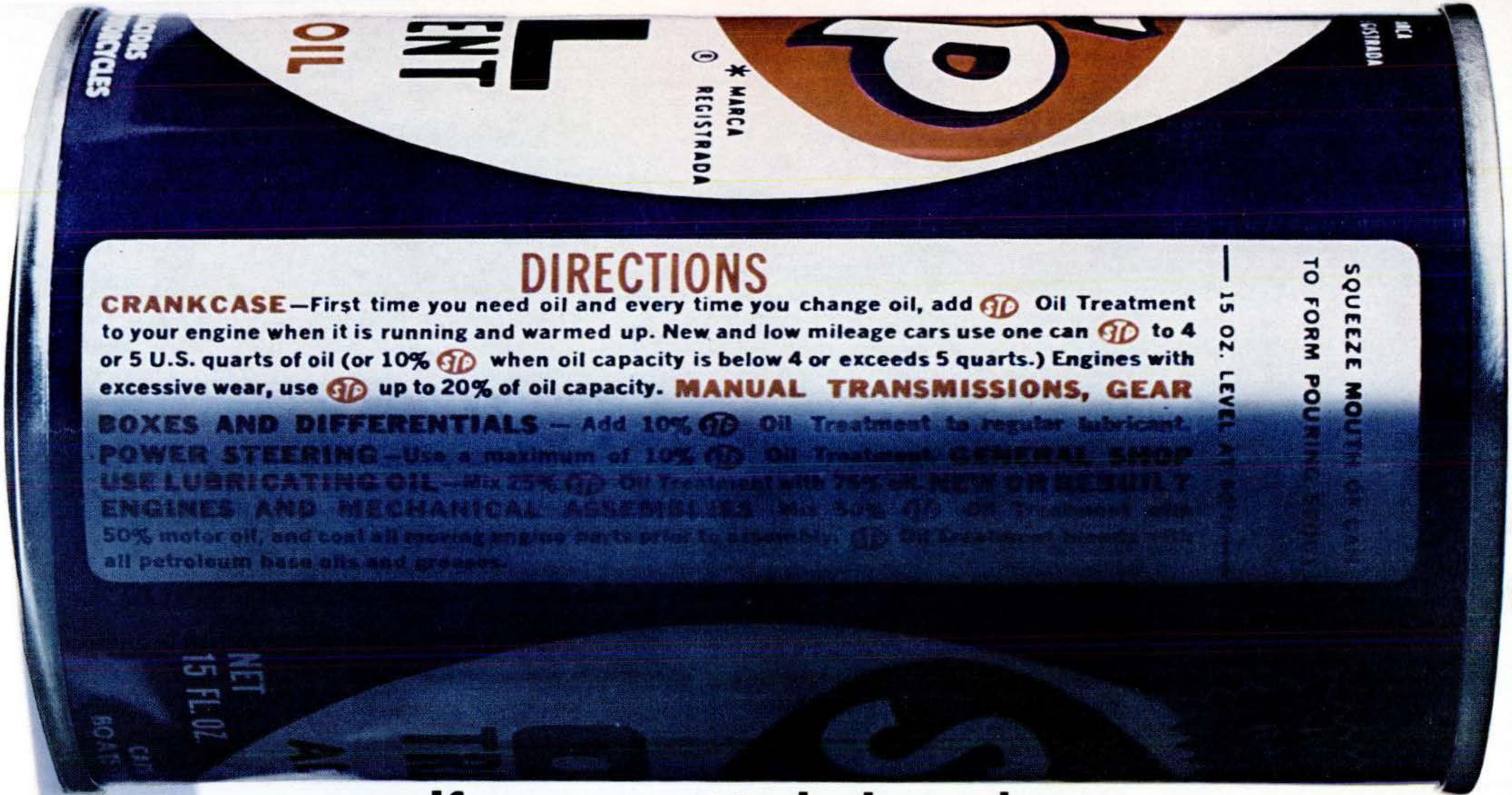

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